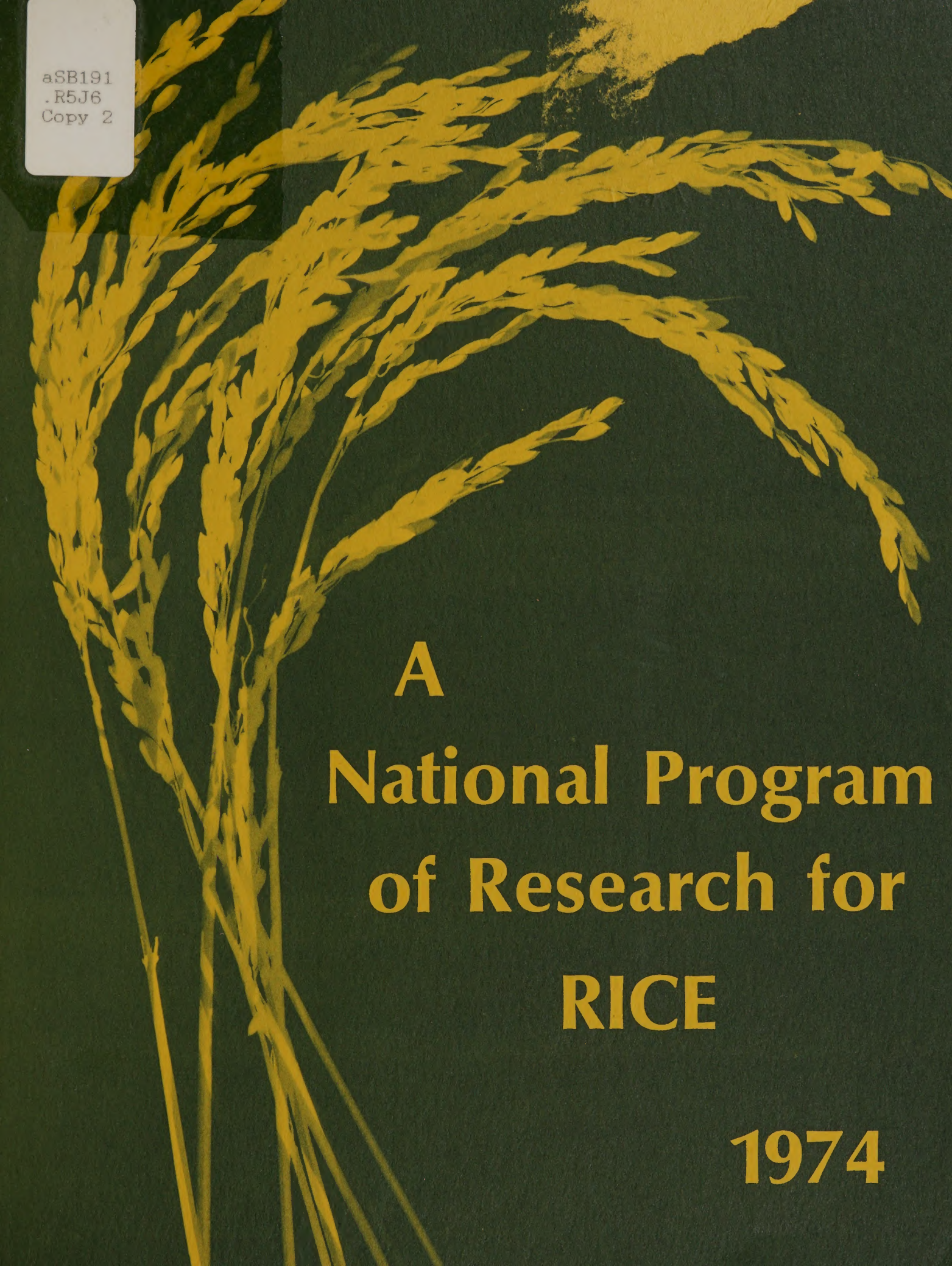

A National Program of Research for RICE

1974

James J. Spadaro

A NATIONAL PROGRAM OF RESEARCH FOR RICE

1974

PREPARED BY

A JOINT TASK FORCE OF THE STATE
AGRICULTURAL EXPERIMENT STATIONS
AND THE UNITED STATES DEPARTMENT
OF AGRICULTURE

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PREFACE

AUTHORITY: This Task Force Report is part of a continuing effort of the U.S. Department of Agriculture and the State Agricultural Experiment Stations to assure coordination of research studies within the Department, with industry, and with other related research groups. In 1966, A National Program of Research for Agriculture, commonly called the Long-Range Study, was prepared by representatives of USDA and State Agricultural Experiment Stations. Ten major goals for research were defined to enable agriculture to meet national objectives. The USDA-SAES established a list of 91 research problem areas (RPA's) associated with the first nine goals and recommended levels of SMY's for FY 1972 and 1977 for each RPA. In 1969 the Secretary of Agriculture, by memorandum, established the Agricultural Research Policy Advisory Committee (ARPAC) for planning, evaluating, coordinating, and supporting long-range research programs with equal representation in ARPAC from USDA and state agencies. In addition, the Agricultural Research Planning and Facilities Subcommittee (ARPF) was set up to conduct studies and carry out planning for the parent committee. In February, 1969, A National Program of Research for Rice, prepared by a joint Task Force of the U.S. Department of Agriculture and the State Universities and Land Grant Colleges, was issued under the national program.

In 1971, ARPAC adopted a proposal from ARPF to establish a cooperative USDA-SAES system for planning and implementing research on a regional and national basis. ARPF identified 39 research programs under 6 major categories. These categories were: natural resources; forest resources; crops; animals; people, communities, and institutions; and competition, trade, adjustment, and price and income policy. In August 1972, the first meeting of the Southern Regional Agricultural Research Planning Committee (SRARPC) was held in New Orleans, Louisiana for initial planning and designation of Southern Regional Administrative Task Force representatives.

The Southern Regional Task Force for Rice held an organizational and planning meeting at the U.S. Delta States Agricultural Research Center, Stoneville, Mississippi, on August 14, 1973. The Task Force chairman, co-chairman, and subcommittee groups were selected. Topic assignments were given to each subcommittee. Because California is the only state that produces commercial rice outside of the Southern Region, representatives from that state were invited, through the Director of the University of California Agricultural Experiment Station and the Deputy Administrator, Western Region, Agricultural Research Service, to join forces with the Southern Regional group. The invitation was accepted. At the second Task Force meeting in Lafayette, Louisiana, February 20, 1974, representatives from the Southern and Western Regions reviewed the written material and selected national research priorities. Preparation of the National Task Force Report for Rice was completed by correspondence. The task force members circulated their respective reports to other rice researchers in their respective disciplines who then served as resource people for reviews and comments.

This report is directed toward describing the current national rice situation and the direction of needed research. It is anticipated that later reports will update this release either annually or biennially as the situation changes and as additional information is available.

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INTRODUCTION

The joint USDA-SAES Rice Task Force was charged with reviewing the current level of effort in various areas of rice research as of 1974 and indicating which areas need emphasis now and during the next 10 years. A priority in descending order from 1 to 5 was to be assigned to each research problem area. The Task Force also was to recommend any need for changes in distribution of current SMY's and any need for increased SMY's as of 1979 and 1984. In addition, the Rice Task Force was to determine the most efficient procedures for organizing and carrying out the specific research involved. Taking present conditions and organization into account, the Task Force recommends the allocation of sufficient SMY's to satisfactorily conduct the needed research as summarized in Table 1 and as indicated in the individual project area outlines. The Research Problem Areas (RPA's) included in this report are 207, 208, 209, 307, 308, 316, 405, 406, 407, 408, 501, 503, 506, 601, 604, 702, and 901.

GENERAL SITUATION: Rice was grown on about 2,569,000 acres in 1974. It is a major crop in Arkansas, California, Louisiana, and Texas. Rice also is an important crop in the "Delta" area of Mississippi and smaller acreages are grown in Missouri and several other states. Rice is a very important world food crop and, for many years, the United States has been the leading country in the exporting of rice. This is of considerable importance in efforts to maintain a balance of payments.

Rice is grown in the United States on many types of soil and under a wide range of climatic and other environmental conditions and is subject to numerous production hazards. Farm management practices and cropping systems followed by rice growers in this country vary widely. Consumers demand rices with different cooking and processing characteristics and, recently, considerable interest has been shown in industrial type (non-food) rice. Also, with the trend toward "natural-type" foods, interest is increasing in the development of rice with higher protein content and otherwise increased nutrient content.

Diseases, weeds, and insects are serious pests of growing rice. As the push for higher grain production continues, the complex interrelationships involving increased fertilizer rates and other intensified cultural and management practices and increased potential damage from these pests become more apparent. The control of these pests and the desired stabilization of rice production will require increased and concerted efforts to better understand the interrelationships involved and develop resistant varieties and needed control measures. Because rice is grown under flood irrigation in the United States, cultural and pest control problems often are quite different than for upland cereal crops. Therefore, specific research with rice is required to solve these problems.

Rice is grown under many ecological conditions. Experiments must be conducted under each ecological condition to determine the best cultural practices and best methods to control diseases, insects, weeds, and other pests. The new short-strawed, lodging resistant and fertilizer responsive rice varieties often require more specific cultural and management practices than did the older and taller varieties to reach their maximum yield potentials. Rice production in the United States is fully mechanized. Since rice is flood-irrigated, field operations usually are conducted under conditions that require heavy-duty implements which must be improved or developed by research.

Rice varieties and available breeding stocks must be evaluated to find the types that: 1) are most resistant to lodging, diseases, insects, and other production hazards; 2) respond best and make most efficient use of available native and applied soil fertilizers; 3) have the most efficient plant types and the highest possible levels of photosynthetic efficiency; 4) have other desirable plant characteristics; and 5) have the desired processing, cooking, and nutritional characteristics. The genetic inheritance of these characteristics must be determined and all possible desired characteristics combined in new improved varieties.

Rice in the United States is harvested with a moisture content above the safe storage level and most is stored where air temperature and relative humidity are quite high. This increases the hazard of storing rice. Additional research is needed on drying and storing rough, brown, and milled rice to prevent losses in quantity, quality, and nutritional value caused by fungi, insects, and other possible factors. The need for improved nutritional value of rice and the development of new uses and new products should be fully explored and appropriate lines of research developed. An improved system of grades and standards recognizing meaningful factors should be developed. Improved handling techniques and equipment also are needed to reduce the cost of labor and losses in processing. Additional information and efforts are needed to help the rice industry further develop effective marketing strategies and promotional activities and increase foreign markets. There also is a need to develop the best possible uses for rice by-products and methods for disposal of crop residues to minimize any detrimental effects to the environment.

POTENTIAL BENEFITS: The character and magnitude of the potential benefits of the individual research program areas are based on the 1974 production of 114 million 100-pound bags of rice on 2.57 million acres. The value of the 1974 crop was $1,140 million based on an average price of $10.00 per 100 pounds.

PRESENT EFFORT: In 1974 it was estimated that 53.6 scientific man-years of effort were expended on rice research in the United States. This was divided about equally between USDA and SAES. An undetermined amount of private effort was expended but this probably was rather limited. The public agency work was done principally at two locations in each of the major rice-producing states, at one location in a moderate-acreage state, and at two or three federal laboratories. Federal and state effort is about equal in protection research. In production efficiency research, federal agencies have conducted research primarily in breeding and state agencies have devoted more of their attention to other phases of rice production research. A major part of the research on consumer acceptance, new products, and marketing efficiency has been by federal agencies.

FUTURE EFFORT: It is believed that future rice research should follow the same general philosophy as the present research. That is, both state and federal agencies should engage in basic and applied research and share the information fully and promptly with farmers, industry, and consumers. The allocation of federal and state personnel to rice research problems must of necessity be based upon the availability of funds and personnel. Insofar as possible, research should be planned to give results with wide adaptation. There are certain types of pest control and production problems that are rather narrow; however, much of the basic research in these two areas will have wider application. Results of research in the areas of consumer acceptance, new product development, quality control, and marketing efficiency will have wide application.

Only minor specific reallocations of present SMY's are recommended in this report. The Rice Task Force recommends substantial increases in research efforts under most of the RPA's that include rice if the United States is to be able to meet the demands for greatly increased food production. Improved control methods for pests, diseases, weeds, and other production hazards are badly needed. Basic genetic studies and improved breeding and screening procedures need major increases in research effort as do other phases of production research. Greater research efforts should be expended on increasing nutritive value of rice, improving and maintaining high market quality, developing new food uses for rice, and improving the uses of rice by-products. Additional research is needed to alleviate possible pollution from production practices and from disposal of rice hulls.

The current allocation of scientific man-years expended on rice research and increased levels recommended by the Rice Research Task Force for 1979 and 1984 are presented in Table 1.

SUMMARY TABLE OF CURRENT SCIENTIFIC-MAN-YEARS AND RECOMMENDED LEVELS FOR RICE RESEARCH IN THE UNITED STATES

RPA No.	Title	CRIS Inventory 1972	Current Estimates	10% Increase*	Number of SMY's Recommended for: 1979	1984
207	CNTR PESTS FLD CROPS	4.3	3.9	4.3	9.0	10.0
208	CNTR DIS FIELD CROPS	4.5	5.8	6.4	12.0	12.0
209	CNTR WEEDS FLD CROPS	2.8	3.1	3.4	7.0	8.0
307	IMP BIO EFF FLD CRP	18.7	14.2	15.6	25.5	25.5
308	MECH PROD FIELD CROPS	0.4	2.1	2.3	7.0	9.0
316	FARM BUS MGT	1.0	1.0	1.1	1.5	2.0
405	PROD FLD CROP IMP ACPT	2.2	2.4	2.6	5.0	6.0
406	NEW IMP FOOD FLD CROP	4.0	4.6	5.1	9.0	9.5
407	NEW IMP NON-FOOD FC	0.8	0.8	0.9	7.0	7.0
408	MKT QUAL FIELD CROPS	3.1	3.5	3.8	10.5	11.0
501	IMP GRADES & STANDS	2.9	2.8	3.1	5.0	6.0
	TOTAL	44.7	44.2	48.6	98.5	106.0
503	MKTG EFF AGRI PRODS	2.5	0.4	0.4	1.5	2.0
506	SPLY DEMAND AND PRIC	0.5	1.3	1.4	2.0	2.0
601	FGN MKT DEVELP	0.5	3.8	4.2	6.5	7.0
604	PRO DEVLPMT/MKTG FRGN	3.1	3.7	4.1	4.0	4.0
702	FOOD PROT FROM TOX	1.0	0.2	0.2	2.0	2.0
901	ALLEV POLLUTION	1.6	0.0	0.0	4.0	4.0
	TOTAL	9.2	9.4	10.3	20.0	21.0
	GRAND TOTAL	53.9	53.6	58.9	118.5	127.0

* SMY's computed from previous column.

Summary of Research Problem Area 207 - Control of Pests of Field Crops

Problem	Priority	SMY's				
		Current	No Increase	10% Increase	Recommended 1979	Recommended 1984
A. Control of Insects by Developing Resistant Varieties of Rice	1	1.2	1.2	1.3	2.0	3.0
B. Biological Control of Insects Through the Use of Parasites, Predators, and Pathogens	2	0.4	0.4	0.4	1.5	1.5
C. Biology of Insects Attacking Rice	2	0.6	0.6	0.7	1.5	1.5
D. Chemical Control	3	1.0	1.0	1.1	1.0	1.0
E. Techniques for Repelling and Excluding Birds, Rodents, and Other Wildlife	3	0.0	0.0	0.0	1.0	1.0
F. Develop New Noninsecticidal Approaches to Insect Control	4	0.2	0.2	0.2	1.0	1.0
G. Use of Cultural Practices to Minimize Insect Damage	4	0.2	0.2	0.2	0.5	0.5
H. Improved Methods and Equipment For Applying Pesticides and Other Insect Control Agents	5	0.3	0.3	0.3	0.5	0.5

CONTROL OF INSECTS BY DEVELOPING RESISTANT VARIETIES OF RICE

RPA 207-A

PRIORITY: 1

SITUATION: The development of insect-resistant varieties offers an effective, economical and safe way to manage insect pests attacking rice. Varieties resistant to some stem borer and leafhopper species have been recently developed in Asia. Screening of varieties from the USDA World Collection of Rices and numerous nurseries has recently provided several varieties that are resistant to stem borer species of the southern U.S. Other varieties appear to be tolerant to the rice water weevil. Research is now in progress to incorporate germplasm resistant to stem borers into acceptable varieties. Research needs to be intensified to conclusively determine suspected resistance or tolerance of some varieties already screened against other insect pests and incorporate these in a breeding program as soon as feasible. The development of insect-resistant varieties is a long-term research program requiring a continuous effort since strains of insects often develop that can attack varieties that were previously resistant. Better methodology is needed to conclusively determine resistance to some rice insect pests. A germplasm bank needs to be established to include all possible sources of resistance to rice insects as they become known. Resistant germplasm should be introduced, as available, into breeding programs for use in developing high yielding, well adapted, insect-resistant varieties.

OBJECTIVES: To seek, find, and identify sources of insect-resistant germplasm in rice varieties. Determine the nature of resistance, mode of inheritance, and establish a germplasm bank of resistant genotypes. Assist plant breeders in developing rice varieties that are insect resistant as well as high yielding and well adapted.

RESEARCH APPROACHES:

A. Collect and evaluate rice varieties from all the rice-growing areas for insect resistance. Establish a germplasm bank of resistant genotypes.

B. Transfer the resistant germplasm to well adapted varieties using established genetic techniques and breeding practices.

C. Study the genetics and manner of inheritance of rice insect resistance, using various cytogenetic and genetic techniques.

D. Develop varieties and breeding lines that are resistant to more than one insect.

E. Determine the effect of growing resistant varieties over large areas on indigenous insect pest, parasite, and predator populations.

F. Determine the presence and abundance of physiological races of insect species, if and when they occur, and take immediate steps to find germplasm resistant to these new physiological races.

G. Conduct basic chemical, physiological, and genetic studies to determine the nature of resistance.

H. Coordinate with research under RPA's 208, 209, 307, 308, 405, and 408.

POTENTIAL BENEFITS: Insect-resistant varieties will reduce the need for insecticides; decrease hazards to man, beneficial insects, and wildlife; lessen the danger of contamination of food, feed, soil, and water; lower the cost of production; conserve energy; and increase the yield and quality of rice.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.2		
No increase	1.2		
10% increase	1.3		
Recommended	-	2.0	3.0

BIOLOGICAL CONTROL OF INSECTS THROUGH THE USE OF PARASITES, PREDATORS, AND PATHOGENS

RPA 207-B

PRIORITY: 2

SITUATION: Parasites, predators, and other biological control agents may play a major role in reducing rice insect populations. Egg parasites are believed to be key mortality factors in keeping stem borer populations and injury below the threshold of economic damage. Parasites and predators sometimes play an important role in reducing populations of the rice stink bug, armyworms, leaf-rollers, and other insect pests of rice. Under some conditions naturally occurring diseases may terminate what appears to be an extensive insect outbreak. There is need for research to determine what native species and physiological races of beneficial organisms occur in rice, their role in reducing pest populations, and whether practices can be developed to enhance the benefits derived from them.

OBJECTIVE: To make maximum use of parasites, predators, and insect pathogens to control insects attacking rice.

RESEARCH APPROACHES:

A. Identify the indigenous predators, parasites, and pathogens of insects attacking rice in the United States and evaluate their effectiveness.

B. Search for and evaluate the effectiveness of exotic parasites, predators, and diseases that potentially can be used to control major insect pests attacking rice in the United States.

C. Develop techniques for mass production and release of parasites, predators, and insect pathogens, and evaluate these organisms for field control.

D. Investigate the feasibility of habitat improvement for the encouragement of native or imported biological control agents.

E. Coordinate with research under RPA's 208, 209, 307, and other aspects of 207.

POTENTIAL BENEFITS: Reduce the cost of rice production by reducing or eliminating the need for insecticides. Reduce hazards, detriment to nontarget organisms, chemical residues, pollution, and use of energy. Increase yield and quality of rice by reducing insect damage.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.4		
No increase	0.4		
10% increase	0.4		
Recommended	-	1.5	1.5

BIOLOGY OF INSECTS ATTACKING RICE

RPA 207-C

PRIORITY: 2

SITUATION: Before meaningful research studies can be conducted to develop more effective control measures, the insect pests, parasites, and predators found in rice must be systematically identified and classified. There is a need for identification and classification of physiological races of parasites that have apparently developed in rice fields. Additional basic information on biology, ecology, behavior, life cycle, life history, host range, population dynamics, and genetics is needed on all insects attacking rice to develop better control methods. Weak links in insect life cycle development must be found and exploited through biological studies to develop new and/or more effective control measures.

OBJECTIVE: Determine the life history, distribution, occurrence, abundance, habits, nutritional requirements, and other biological, physiological, and ecological characteristics of pest insects, parasites, and predators in rice for the development of various types of control for insects attacking rice.

RESEARCH APPROACHES:

A. Conduct taxonomic studies on all insects attacking rice, and on their parasites and predators, in order to identify and classify them by using standard taxonomic keys. Develop tests for classifying physiological races. Prepare reference collections of the different species and physiological races.

B. Conduct laboratory and field studies on rice insects using accepted biological procedures and techniques to obtain basic information on population dynamics, mating behavior, migration habits, and other biological activities which can be used to conduct suppression, eradication, or control studies and to develop life tables for different ecological areas.

C. Determine the effect that various insect populations have, at different times and under different growing conditions, on yield and quality of rice, and determine the economic injury threshold for each insect species.

D. Determine the nutritional requirements of rice insects, using standard laboratory procedures, and develop artificial diets for the mass rearing of the insects to facilitate study of life cycles and development of control measures.

E. Coordinate with RPA 307 and other aspects of 207.

POTENTIAL BENEFITS: Reduce the cost of rice production by more efficient use and timing of insect control measures.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.6		
No increase	0.6		
10% increase	0.7		
Recommended		1.5	1.5

CHEMICAL CONTROL

RPA 207-D

PRIORITY: 3

SITUATION: Insecticides have been used very effectively to control insect pests of rice. However, insects can become resistant to insecticides that formerly gave satisfactory control. A need for new insecticides to control rice insect infestations will exist for the foreseeable future. Often insecticides are not compatible with herbicides used on rice. Some insecticides reduce populations of beneficial insects and wildlife. Research is needed to find materials with maximum biological activity against the target insect and minimum activity against man, animals, and other useful organisms in the environment. Selective biodegradable insecticides are needed that do not accumulate in plant and animal tissues or in the environment and that are not magnified through food chains. Improvements in formulations, methods of application, and timing of treatments are needed to reduce residue problems in nontarget areas and lessen the amounts of insecticide used.

OBJECTIVE: To find insecticides that are less costly and more effective against target pests; leave no objectionable residues in rice, soil, and water; result in minimum air pollution; cause minimum reduction in populations of beneficial insects; and are less or nonhazardous to man and animals.

RESEARCH APPROACHES:

A. Evaluate new insecticides in the laboratory and field, using accepted procedures and techniques for insect control. Conduct studies to determine if they are compatible with other agrochemicals being used on rice.

B. Test various insecticide formulations, rates, and application timing against different rice insect species, using both ground and aerial equipment.

C. Determine effect of insecticides on beneficial insects, wildlife, domesticated animals, and man.

D. Determine chemical residues in the plant, soil, and grain after insecticide application to rice. Develop methods of reducing residues.

E. Coordinate with research under RPA's 208, 209, and 307.

POTENTIAL BENEFITS: Provide safer, more effective insecticides that are less hazardous to man, domesticated animals, and beneficial organisms, and that lower production costs and increase yield and quality of rice.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.0		
No increase	1.0		
10% increase	1.1		
Recommended	-	1.0	1.0

TECHNIQUES FOR REPELLING AND EXCLUDING BIRDS, RODENTS, AND OTHER WILDLIFE

RPA 207-E

PRIORITY: 3

SITUATION: Birds and rodents often cause damage to plantings of rice. For example, young seedlings may be destroyed, and developing and matured grains eaten or shattered by these pests; they may also spread weed propagules from weed infested to noninfested areas. Noisemaking devices, scarecrows, recordings of bird distress calls, predator scents and other chemical repellents, trapping, dynamiting of roosts, poisoning, and shooting are used to repel, exclude, and kill birds and other wildlife. Methods which destroy the offending wildlife are highly controversial. Other methods are generally either low in effectiveness, expensive, or poorly adapted for use in large fields. Although there is no method at present to quantify losses in rice caused by birds and other wildlife, there are data to indicate that the losses are significant. Biologists of the U.S. Bureau of Sport Fisheries and Wildlife reported estimated losses of about 60 lb/A (rough rice) caused by birds in Arkansas. Losses caused by muskrats in Arkansas rice fields were estimated at $800,000 in 1966 and $900,000 in 1967. On the other hand, wildlife, particularly the bird population, is beneficial in some respects. The diet of birds includes significant proportions of harmful insects, weed seed, and other pests that affect rice. The Bureau of Sport Fisheries and Wildlife of the U.S. Department of the Interior is currently devoting approximately 3.0 SMY's annually to research on amelioration of animal damage to rice.

OBJECTIVE: To identify, characterize, and mitigate losses caused by birds, rodents, and other wildlife without endangering the balanced existence of any species involved.

RESEARCH APPROACHES:

A. Identify the exact species of wildlife involved in specific situations and measure the benefits and losses they cause in these situations.

B. Investigate different types of flashing lights, recorded sounds, and other nonchemical techniques as repellents.

C. Develop safe, economical repelling chemicals for use on planted seed and ripening grain.

D. Characterize the economics of public reimbursement of individuals sustaining severe losses in locations adjoining wildlife refuges.

E. Investigate the potential of breeding rice for resistance to damage from wildlife.

F. Investigate the potential of using controlled sterilization to reduce overabundant local populations of depredating species, such as blackbirds, starlings, and sparrows.

G. Develop safe, effective lethal control methods for locally overabundant depredating bird populations.

H. Coordinate with research of RPA's 208, 209, 307, 308, 316, and other aspects of 207 with similar research associated with other crops and with research conducted by the U.S. Department of the Interior.

POTENTIAL BENEFITS: Reduction of losses in stands and yields. Although we have little data for quantifying the losses, crop scientists and wildlife specialists estimate that current annual losses in rice are approximately 1% of the crop. We could logically expect to reduce these losses by 25%.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.0		
10% increase	0.0		
Recommended*	-	1.0	1.0

* Suggest 0.25 SMY in each of the major rice-producing states to coordinate with research conducted by the U.S. Department of the Interior.

DEVELOP NEW NONINSECTICIDAL APPROACHES TO INSECT CONTROL

RPA 207-F

PRIORITY: 4

SITUATION: Insects are attracted to various stimuli including specific substances, host plants, sex attractants, sound, light, and other electromagnetic radiation. The use of chemosterilants or insecticides in conjunction with attractants has good possibilities of controlling insects attacking rice. The possibility of using natural or synthetic hormones to control rice insects should be investigated. There has been little or no research conducted on rice insects for their own destruction by employing sterility or other genetic principles. It has been demonstrated that when sterile insects are released and are able to compete with the normal insect population for reproduction, the biotic potential of the natural population can be greatly reduced.

OBJECTIVE: Determine methods of sterilizing insects and of isolating attractants, hormones, and other biologically active materials and use this information to develop methods of controlling or suppressing pest insect populations.

RESEARCH APPROACHES:

A. Locate, isolate, and identify hormones that can be used to interfere with insect growth and development.

B. Determine the possibility of sterilizing rice insects with radiation or chemosterilants, using established bioradiation techniques, and determine if the sterile male release technique can be used for area-wide control.

C. Isolate sex attractants from insects attacking rice. Conduct laboratory and field studies on the feasibility of controlling insects by the use of attractants.

D. Evaluate light, sound, and other electromagnetic radiation as possible insect attractants or repellants.

E. Coordinate with other research under RPA 207.

POTENTIAL BENEFITS: Lower the cost of production and increase yield and quality of rice. Reduce hazards and undesirable side effects of insecticides.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.2		
No increase	0.2		
10% increase	0.2		
Recommended	-	1.0	1.0

USE OF CULTURAL PRACTICES TO MINIMIZE INSECT DAMAGE

RPA 207-G

PRIORITY: 4

SITUATION: Frequently a slight modification of cultural practices in the growing of a crop such as rice may prevent or lessen insect damage. These modifications may include changes in time of planting, methods of planting, weed or disease control, crop rotation, fertilizer application, etc. Special emphasis should be placed on studies dealing with water management practices in relation to insect infestations. Cultural practices alone may not give completely satisfactory insect control; however, they are often important in minimizing damage and in reducing the need for and cost of insecticidal control.

OBJECTIVES: To determine the effect of production and cultural practices on insect populations, and to identify the changes in insect damage associated with them. Combine feasible practices into integrated insect control systems suitable for use by rice growers.

RESEARCH APPROACHES:

A. Study the effect of various crop rotations, weed or disease control, fertilization, water management practices, etc., on insect populations and damage.

B. Identify changes in pest insect, parasite, and predator populations as related to changes in management practices.

C. Coordinate with RPA's 208, 209, and 307.

POTENTIAL BENEFITS: Reduce or eliminate the need of costly insect control measures by using cultural practices that benefit rice but reduce infestation and damage of insect pests.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.2		
No increase	0.2		
10% increase	0.2		
Recommended	-	0.5	0.5

IMPROVED METHODS AND EQUIPMENT FOR APPLYING PESTICIDES AND OTHER INSECT CONTROL AGENTS

RPA 207-H

PRIORITY: 5

SITUATION: Insecticides will continue to be needed in the foreseeable future to control insect pests of rice. The use of materials more specific to target insects, more effective formulations, better equipment and methods of metering, conveying and distributing pesticides, and more precise timing of applications will provide better control and minimize detriment to nontarget organisms, reduce residues, lessen contamination of the environment, and reduce the cost and need for insecticides. Improved methods of releasing various species of sterile insects, parasites, predators, insect-disease-causing pathogens, viscous lure-toxicant mixtures, baits, etc., are essential to progress in these control methods. Improvements are needed in spray and granule emitter systems relevant to nozzle types, spacing, gate openings, spreader mechanisms, etc., that will give the best control of droplet size, distribution patterns, and insecticide drift to nontarget areas. Insecticides applied while planting or water managing, or concurrently with other agrochemicals such as fertilizer, fungicides, nematicides, herbicides, etc., can prevent unnecessary equipment operation, reduce costs, and conserve energy.

OBJECTIVE: Develop improved methods and equipment for applying pesticides and other control agents, and thus enhance control of target pests, lessen contamination of the surrounding environment, reduce the need for additional equipment operation, reduce costs. and conserve energy.

RESEARCH APPROACHES:

A. Develop a spray emitter that will give improved control of droplet size and thereby reduce drift of fine particles.

B. Improve the deposition efficiency of sprays and dusts on plant leaves by studies using electrostatic charge, agents, and additives to reduce evaporation of water in spray droplets.

C. Determine the effects of weather upon the evaporation and rate of fall of spray droplets.

D. Continue studies on the packaging and release of sterile insects, predators, and parasites from aircraft to develop methods to reduce physical damage of the insects and reduce cost of handling.

E. Develop equipment for the distribution of viscous lure-toxicant mixtures, virus sprays, and other materials used for the control of insect pests.

F. Coordinate with RPA's 208, 209, 307, and other aspects of 207.

POTENTIAL BENEFITS: Provide safer and more economical means of applying insecticides and other insect control agents with increased efficiency. Will reduce the quantity of insecticides and/or control agents needed, hazards, pollution, equipment operation, and energy consumption. Will increase yield and quality of rice.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.3		
No increase	0.3		
10% increase	0.3		
Recommended	-	0.5	0.5

Summary of Research Problem Area 208 - Control of Diseases of Field Crops

Problem	Priority	SMY's Current	No Increase	10% Increase	Recommended 1979	1984
A. Control of Diseases Through Genetics and Breeding	1	1.0	1.0	1.1	3.0	3.0
B. Control of Seedling Diseases and Seed Rot	1	1.0	1.0	1.1	1.5	1.5
C. Stem Rot and Other Lower Stem Diseases of Rice	1	1.0	1.0	1.1	1.5	1.5
D. Etiology of Leaf and Sheath Diseases and Other Endemic or Introduced Diseases Including Virus Diseases	2	0.2	0.2	0.2	1.0	1.0
E. The Role of Fungi in Sterility	2	0.2	0.2	0.2	0.5	0.5
F. Biology and Control of Rice Kernel Smut Disease	3	0.4	0.4	0.4	1.0	1.0
G. The Role of Fungi in Kernel Discoloration	3	0.4	0.4	0.4	0.5	0.5
H. Chemical or Metabolic Basis for Disease Resistance	3	0.1	0.1	0.1	0.3	0.3
I. Epidemiology and Control of Rice Blast Disease	3	0.2	0.2	0.2	0.5	0.5

(Continued)

Summary of Research Problem Area 208 (continued)

Problem	Priority	SMY's Current	No Increase	10% Increase	Recommended 1979	Recommended 1984
J. Chemical Control of Blast and Other Diseases of Rice	3	0.8	0.8	0.9	1.0	1.0
K. Etiology and Epidemiology of Rice Weed Pathogens	4	0.2	0.2	0.2	0.5	0.5
L. Control of Ring Nematodes in Rice	4	0.3	0.3	0.3	0.5	0.5
M. Improved Equipment for the Application of Chemicals to Rice for the Control of Diseases	4	0.0	0.0	0.0	0.2	0.2

CONTROL OF DISEASES THROUGH GENETICS AND BREEDING

RPA 208-A

PRIORITY: 1

SITUATION: Rice diseases reduce yield, lower quality, and restrict managerial options of growers, seed-producers, millers, and processors. The magnitude of these losses is imprecisely determined but is considerable each year and quite substantial in some years. Methods of identifying resistance in varieties and breeding lines to the races of the rice blast pathogen and physiological straighthead have been in use for several years and, more recently, procedures of screening for resistance to Helminthosporium seedling blight, sheath blight, and stem rot have been developed. Varieties have been released with resistance to rice blast and straighthead but in no variety is there combined resistance to several of the major diseases, nor is there suitable resistance to any one of these diseases in all grain types.

OBJECTIVES: To identify genes and/or cytoplasmic factors for resistance to rice blast, straighthead, Helminthosporium seedling blight, sheath blight, and stem rot; determine their modes of inheritance and incorporate high levels of resistance into short-, medium-, and long-grain varieties having superior agronomic and quality characteristics.

RESEARCH APPROACHES:

A. Monitor the spectrum of blast races annually throughout the rice growing region and select the most prevalent ones for challenging advanced nursery materials.

B. Search for sources of resistance to each disease among entries in the world rice collection, related species, and all breeding lines and varieties.

C. Employ mutagenic agents, chromosome doubling, and other cytological techniques to break undesirable linkages and to recover resistant genes from inferior genomes.

D. Determine the mode of inheritance of resistance to each disease.

E. Incorporate resistance into superior agronomic varieties of each grain type and quality class by systematic crossing and testing.

F. Computerize annually all data on disease resistance, making it more readily available and useable in breeding for resistance.

G. Coordinate with RPA's 207, 307, 405, 406, and other aspects of 208.

POTENTIAL BENEFITS: Increases in yield, improvement of processing quality, and greater latitude in selection of varieties for specific production regimes or product market requirements. The magnitude of benefits from this research is estimated to be equivalent to 3% of the total value of the crop.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.0		
No increase	1.0		
10% increase	1.1		
Recommended	-	3.0	3.0

CONTROL OF SEEDLING DISEASES AND SEED ROT

RPA 208-B

PRIORITY: 1

SITUATION: Establishing a stand of uniform, vigorous, healthy seedlings has always been a critical step in the production of rice. It has increased in importance since many management decisions, such as timing of herbicidal or topdress nitrogen applications, are based on the morphological stage of development of the plants. Thus, as well as serving as a source of inoculum for Helminthosporium and Fusarium outbreaks later in the season, disease weakened, irregular stands may lead to herbicide damage or excessive foliage, height, and lodging from improper timing of nitrogen applications. The importance of seedling diseases is accentuated by the increase in very early seeding of rice, especially for double cropping, and the practice of seeding in water for "minimum tillage" production of rice. The water mold Achlya oryzae is especially serious in the latter. Mercury seed-treatment materials have been effective in destroying Helminthosporium in infested and infected seed but such materials are no longer cleared for use in rice. There are other seed-treatment materials reasonably effective against seedborne and soilborne organisms other than Helminthosporium in drill-planted rice but better materials are needed. No suitable seed treatments for water-seeded rice are available.

OBJECTIVE: To locate more effective seed treatment chemicals for control of seedborne, soilborne, and waterborne diseases of rice and make etiological studies so that optimum cultural practices can be recommended for each seedling disease problem.

RESEARCH APPROACHES:

A. Screen existing fungicides for efficacy in controlling seedling blight in soil and water seeding situations.

B. Test experimental fungicides provided by chemical companies, especially the new systemic fungicides, and the available surfactants.

C. Design experiments that coordinate different environmental conditions with the infective and disease development capabilities of the pathogens so that optimum cultural practices can be determined.

D. Examine the available hormone seed treatments for their effectiveness in increasing seedling vigor of rice.

E. Determine the antibiotic potential of rice hulls and their effects on germination.

F. Coordinate with RPA's 207, 307, 308, and other aspects of 208.

POTENTIAL BENEFITS: There will be some saving of seed costs but the major benefits will be more uniform stands to permit increased precision of herbicidal application, nitrogen topdress application, flooding, and draining. Reduced incidence of Helminthosporium leaf and panicle infections later in the season would improve quality. The magnitude of benefits from this research is estimated to be equivalent to 1% of the total value of the crop.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.0		
No increase	1.0		
10% increase	1.1		
Recommended	-	1.5	1.5

STEM ROT AND OTHER LOWER STEM DISEASES OF RICE

RPA 208-C

PRIORITY: 1

SITUATION: Stem rot is typically a disease of the mature rice plant, causing the lower internodes to weaken and thereby encouraging plant lodging. Occasionally, as in 1969, the stem rot fungus caused earlier than normal infection of the lower nodes of rice, girdled the culm or stem, and severe light weight, bleached panicles were the result. Disastrous losses were incurred in Louisiana and elsewhere. Stem rot is a serious disease in California and is receiving considerable research activity from the pathologists there. Artificial inoculations of rice with the stem rot fungus under controlled conditions have revealed large, rapidly spreading lesion development when the culm was injured prior to inoculation and lesions were produced in California without prior injury. Thus, screening for resistance appears to be obtainable if other limiting factors can be solved, such as preventing the loss of pathogenicity of the fungus in culture. *Rhizoctonia solani* can cause severe damage to the lower culm of rice and a crown rot disease of undetermined cause kills tillers and even entire plants in rice fields in Louisiana every year.

OBJECTIVES: To conduct investigations to determine the conditions favorable for stem rot development and develop disease screening methods that can lead to resistance to this disease.

RESEARCH APPROACHES:

A. To determine environmental conditions which favor early infection by the stem rot fungus and formulate cultural practices that will prevent this.

B. To develop reliable screening procedures in the field and in the laboratory to select varietal tolerance to the disease.

C. Perform histological studies to determine the mechanism of penetration, infection, and advancement of the fungus in rice nodal tissues.

D. Set up long-term studies to evaluate the longevity of stem rot sclerotia in soils of differing textures.

E. Study the fundamental aspects of other lower stem diseases of rice so that interim measures of control can be recommended in advance of ultimate control measures.

F. Coordinate with RPA's 207, 307, and other aspects of 208.

POTENTIAL BENEFITS: It is probable that most rice plants at maturity harbor the stem rot fungus or some other lower stem pathogen. Progress toward control of these diseases could lead to sustained profit increases. Injuries to the lower stems and all plant parts above this point ultimately lead to losses of rice equal to 2% of the crop.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.0		
No increase	1.0		
10% increase	1.1		
Recommended	-	1.5	1.5

ETIOLOGY OF LEAF AND SHEATH DISEASES AND OTHER ENDEMIC OR INTRODUCED DISEASES INCLUDING VIRUS DISEASES

RPA 208-D

PRIORITY: 2

SITUATION: Leaf smut (Entyloma oryzae), sheath blight (Rhizoctonia oryzae), and narrow brown leaf spot (Cercospora oryzae) are widely distributed in the southern rice area, occurring annually in most commercial fields as plants approach maturity. Their influence on yield is usually minimal with current varieties and cultural practices but they effect quality by disrupting the normal maturation of grains. Yield reductions are, however, sometimes substantial as changes in varieties and cultural practices occur. The long-grain varieties Bluebelle, Dawn, Starbonnet, and Bluebonnet 50 suffered appreciable yield and quality losses in 1968 over the entire southern rice area as a result of early infection and buildup of sheath blight. The life histories of these three organisms have been elucidated but the disease cycles are not known. Techniques for testing varietal reactions adequately are developed for sheath blight but not for Entyloma and Cercospora. Other endemic or introduced diseases and nematodes become economically important from time to time.

OBJECTIVE: To develop varietal testing procedures for leaf smut, narrow brown leaf spot, and other endemic or introduced diseases or nematodes.

RESEARCH APPROACHES:

A. Survey annually for potential nematode, viral, bacterial, or fungal pathogens and assess their potential importance.

B. Determine the optimum laboratory or greenhouse cultural procedures for each significant or potentially significant pathogen.

C. Develop inoculation procedures under controlled conditions.

D. Establish a disease rating system with enough varieties to obtain a full spectrum of resistance and susceptibility.

E. Determine the degree and extent of variation on pathogenicity in natural populations of the organisms.

F. Determine the host range of the pathogens with emphasis on weeds and crops preceding rice in the rotation.

G. Coordinate with RPA's 207, 307, 405, and 406.

POTENTIAL BENEFITS: Quality improvement and increased efficiency of breeding programs would reduce some of the hazards encountered by seed producers, growers, and millers of new varieties. The magnitude of benefits from this research is estimated to be equivalent to 1% of the total value of the crop.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.2		
No increase	0.2		
10% increase	0.2		
Recommended	-	1.0	1.0

THE ROLE OF FUNGI IN STERILITY

RPA 208-E

PRIORITY: 2

SITUATION: Fungi pathogens on the leaves of rice can also infect and spot rice panicles. To what extent such pathogens - Helminthosporium oryzae, Cercospora oryzae, Piricularia oryzae, and Rhizoctonia oryzae - cause sterility and light grains in rice is poorly understood. Sterility varies markedly with rice varieties, Starbonnet and Bluebonnet being extremely prone to the problem, and from season to season. Undoubtedly environmental factors play an important role in the problem but little dependable evidence is available. Secondary fungi that cause discoloration of grains are quick to follow primary injury caused by the pathogens mentioned above. Heavy dew rarely evaporates from rice before late mornings, thus providing a period of 12 hours of heavy moisture on rice panicles and leaves. Extensive damage occurred in Texas rice in 1973 as well as in Arkansas, Louisiana, and Mississippi.

OBJECTIVE: To conduct a systematic study of the role of fungi in sterility in rice.

RESEARCH APPROACHES:

A. Using the rice variety Starbonnet, make close observations for signs of damage to panicles from early emergence to milk-filled grains.

B. Apply methods for detection of fungi, both pathogens and secondary fungi. Forced fungus fruiting and isolation procedures should be used.

C. Determine how soon secondary fungi begin to colonize dead panicle tissues after pathogen infection.

D. Apply chemicals and other protective procedures to try to reduce or eliminate sterility in Starbonnet.

E. Use chemicals such as tetrazolium to test grains and grain parts for early signs of mortality.

F. Monitor environments during flowering and early grain development with special emphasis on high winds that are known to prevent fertilization, thus attempting to identify environments that contribute to sterility.

G. Plant a variety of low sterility index, such as Nato, as a crop mixture with Starbonnet to try to reduce sterility.

H. Coordinate with RPA's 307, 405, 406, 408, and 702.

POTENTIAL BENEFITS: Good to excellent rice stands and vegetative growth may be followed by high levels of sterility. Control of sterility in isolated instances could increase profits as much as 50%.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.2		
No increase	0.2		
10% increase	0.2		
Recommended	-	0.5	0.5

BIOLOGY AND CONTROL OF RICE KERNEL SMUT DISEASE

RPA 208-F

PRIORITY: 3

SITUATION: The rice kernel smut disease has increased in prevalence and severity with the increased use of nitrogen fertilizer. Yield loss estimates range from 1-3% annually with losses as high as 25% occurring in individual fields. Likewise, substantial losses are incurred in milling and parboiling. Partially smutted kernels remaining in milled rice seriously detract from its appearance and in the parboiling process they impart a grey color to the entire batch. Several high yielding potential varieties have not been released largely because of their susceptibility to kernel smut. Life history studies on the causal fungus, Tilletia barclayana, reveal that it infects individual rice florets at anthesis. The parameters of each environmental element, host physiology, and inoculum concentration necessary for infection and symptom expression have not been elucidated. Therefore, rather than reaction testing under controlled conditions, searches for sources of resistance and screening of breeding material to develop resistant varieties have been limited to small outlying nurseries in "smut suspect" locations in Arkansas.

OBJECTIVE: To determine the optimum environment, host physiological condition, and inoculum levels for smut infection and development under controlled conditions.

RESEARCH APPROACHES:

A. Determine the diurnal temperature, humidity, light, and nutrient program for optimal growth of rice in environmental chambers, during the periods of panicle initiation, emergence, and pollination.

B. Inoculate developing, emerging, and pollinating panicles with primary and secondary sporidia in various liquid and dust vehicles.

C. Measure disease development under a wide range of environmental conditions and determine optimum conditions for infection and symptom expression.

D. Determine the relationship between host metabolism, primary nitrogen metabolism, and host reaction to penetration.

E. Select plants with metabolic systems that are unable to support growth of the pathogen or are inhibitive to it.

F. Coordinate with RPA's 307, 405, 406, 408, and 702.

POTENTIAL BENEFITS: These studies will permit systematic searches for resistance and thereby development of resistant varieties, either by inoculation test or simple laboratory test for chemical constituents in varieties and breeding lines. Also, information on environmental requirements for disease development will be helpful in selecting cultural practices inimical to disease development. Potential yield and quality increase benefits have been estimated to be about 1.5% of the current crop.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.4		
No increase	0.4		
10% increase	0.4		
Recommended	-	1.0	1.0

THE ROLE OF FUNGI IN KERNEL DISCOLORATION

RPA 208-G

PRIORITY: 3

SITUATION: The long-standing problem of discolored and pecky kernels in milled rice has been accentuated with the development of parboiling and the concomitant increase in use of rice in precooked foods and convenience foods such as packaged dinners. Blackened kernels are intolerable in these products and must be removed photoelectrically. As in the case of smut, discoloration of the entire parboil batch by these fungi is a significant problem. Parboiling strengthens these damaged kernels, consequently they are more likely to remain intact in the milled rice rather than being broken and removed as they are in the standard milling procedures. Furthermore, the rice import regulations of certain Asian countries that require the complete absence of *Penicillium islandicum* and *P. toxicarum*, two toxin-producing fungi, and the general increased public concern over mycotoxins as carcinogens, have refocused attention on this group of organisms in the microflora of the rice kernels. Several fungi have been isolated consistently from discolored kernels and include *Curvularia lunata*, *Helminthosporium oryzae*, *Trichoconis caudata*, *Nigrospora oryzae*, *Fusarium semitectum*, and *Alternaria* sp.

OBJECTIVE: To survey and identify the fungi associated with discolored rice kernels and elucidate their etiology to the extent necessary for formulating control measures.

RESEARCH APPROACHES:

A. Establish a sampling network of Arkansas, Texas, and Louisiana rice graders, elevator operators, and millers to annually obtain representative rice samples of each variety from several localities and cultural systems.

B. Isolate and identify the fungi from rice of various regions and varieties.

C. Determine means of dissemination, penetration, growth, and overwintering requirements of fungi.

D. Examine anthesis of existing varieties under controlled environmental conditions with time-lapse photography for factors governing opening and closing of florets and the effects of individual fungi on the pollination and kernel maturation process.

E. Search for antibiotics in rice florets or morphological and physiological characters that could be used in selecting varieties able to escape or resist penetration by the fungi and damage from insects to the developing grains.

F. Coordinate with RPA's 307, 408, and 702.

POTENTIAL BENEFITS: Correlation of fungal flora with varieties, localities, and cultural practices would give insight into means of avoiding damage. Discoloration of rice kernels reduces the quality of about 3% of the rice crop.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.4		
No increase	0.4		
10% increase	0.4		
Recommended	-	0.5	0.5

CHEMICAL OR METABOLIC BASIS FOR DISEASE RESISTANCE

RPA 208-H

PRIORITY: 3

SITUATION: The fate of a rice plant as it interacts with disease-inciting organisms in its environment is grossly affected by its physiological condition or biochemical status during the time of this interaction. Cold-weather rice, for example, is more severely infected with brown spot (Helminthosporium oryzae) and is more severely damaged by the rice blast organism during the seedling stage and on "dry ground" rice. Several rice diseases are more severe in the seedling stage and as plants approach maturity, while in the interim stages of development plants are considerably more resistant. Certain rice diseases are diminished by fertilization while others are augmented. Certain herbicides alter the metabolism of rice and affect its reaction to disease. Attempts to attribute these differences in susceptibility to micro or macro morphological characters of the rice plant have been futile. No intensive studies of specific metabolic systems and their relationship to disease development have been made with the prevalent endemic rice diseases.

OBJECTIVE: To relate biochemical mechanisms in rice plants to their reactions to specific pathogens.

RESEARCH APPROACHES:

A. Make comparative studies of specific metabolic systems in resistant and susceptible plants that are healthy or that have been challenged with specific pathogens.

B. Search for key biochemical intermediates in metabolic cycles that correlate with disease reaction.

C. Determine the nutrient requirements of specific pathogens and their relative abundance in plants exhibiting a spectrum of disease susceptibility.

D. Examine plants and pathogens for inhibitors or toxins that give either an advantage toward resisting invasion or an increase in susceptibility.

E. Screen herbicides and related compounds for their efficacy in modifying resistance.

F. Screen breeding lines and varieties for compounds or metabolic systems inimical to disease.

G. Coordinate with RPA's 207, 209, 307, 405, 406, and other aspects of 208.

POTENTIAL BENEFITS: These studies would improve means of testing for disease reaction, provide information upon which to alter cultural practices for increased disease resistance, and establish a basis for application of resistance-modifying chemicals. Benefits included under RPA 208-A and 307.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.1		
No increase	0.1		
10% increase	0.1		
Recommended	-	0.3	0.3

EPIDEMIOLOGY AND CONTROL OF RICE BLAST DISEASE

RPA 208-I

PRIORITY: 3

SITUATION: Blast, caused by Piricularia oryzae, has long been one of the major disease problems of rice grown in the Gulf States, especially Louisiana. Its seriousness varies from year to year, and from location to location. It causes serious economic losses in some fields each year, and is regularly a limiting factor in certain localities. Considerable work has been done on epidemiology of the blast disease in Asia, yet relatively little has been done in the Gulf States. At present it is not known how or where the fungus overwinters in the United States, nor what the primary sources are of inoculum for infection of the next year's crop. It is not known why certain localities have more blast than others, but soil types, differences in climatic conditions, cultural practices, and means of overwintering are all factors which might influence this. Although progress has been made in the development of resistant varieties, new races of the fungus have built up and caused severe losses in new resistant varieties within a few years of their release. This indicates the need to develop other means of control which can be used in the event resistant varieties are attacked by new races.

OBJECTIVES: To identify means of overwintering of the blast fungus, sources of primary inoculum, conditions that affect buildup of the disease to epiphytotic proportions, and means of control of the disease.

RESEARCH APPROACHES:

A. Determine methods of overwintering and sources of primary and secondary inoculum, including a study of the possible role of (1) seedborne infection, (2) alternate hosts, (3) airborne spores from the tropics, and (4) infected stubble and straw.

B. Study variations in local humidity-temperature-soil factors and cultural practices and their influence on blast development in different areas.

C. Design and construct spore catching devices so that a disease forecasting system can be developed.

D. Determine effect of soil amendments such as calcium silicate slags (long used in certain areas of Japan) or rice hulls on development of blast disease in problem areas.

E. Coordinate with RPA's 207, 405, 406, and other aspects of 208.

POTENTIAL BENEFITS: An adequate means of predicting local blast outbreaks and forecasting widespread epiphytotics, together with knowledge of chemical or other means of control, would greatly reduce losses from this disease with a minimum expenditure by the farmer. In localized areas where blast is a problem almost every year, farmers could safely increase fertility rates and realize a 25 to 50% increase in yield. Areawide yield increases would be approximately equivalent to 1% of the total value of the crop.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.2		
No increase	0.2		
10% increase	0.2		
Recommended	-	0.5	0.5

CHEMICAL CONTROL OF BLAST AND OTHER DISEASES OF RICE

RPA 208-J

PRIORITY: 3

SITUATION: Chemical control of diseases of field crops is usually not practiced for economic reasons. Rotten-neck of rice blast could be exceptional, however, because rotten-neck can reduce yields markedly and its occurrence is important for only a short period of time between emergence of the panicle from the boot and filled grains. Studies have been conducted on chemical control of blast for several years. In most years natural infection of Early Colusa by the blast fungus is more than adequate to evaluate chemicals for control. Materials that have provided good to excellent control of blast are Duter 50-W, Hinosan, Benlate, Phosvel, Topsin M, and a new Elanco material; none are labeled for use as a foliar applicant on rice. Yield data are in close agreement with the rotten-neck data. All materials mentioned gave highly significant increases in yield compared with the controls. Hinosan has been applied to 5-acre areas in outfield trials and achieved control of blast as pronounced as that achieved in small-plot tests.

OBJECTIVE: To develop methods of chemical control for use in addition to and in combination with other methods of control of rice diseases.

RESEARCH APPROACHES:

A. It is recognized that the most effective means of control of blast of rice is resistant varieties; chemical control could provide an excellent second level of control.

B. Continue to test chemicals for control of blast, seeking one or more materials that will significantly control rotten-neck with a single application.

C. Tests have shown that materials were most effective when adequate to high fertilization rates were used. In some areas of Louisiana recommended fertilizer rates are not applied because of blast. Chemical control studies can be designed to benefit these growers.

D. Materials that are effective against blast could be effective against other major diseases of rice caused by fungi.

E. In addition to foliar applications, use other treatments such as seed treatment and granular applications in soil to control blast and other diseases of rice.

F. Support efforts of chemical companies to secure approval of effective chemicals for use in rice.

G. Coordinate with RPA's 207, 308, and other aspects of 208.

POTENTIAL BENEFITS: Diseases of rice, year after year, steadily reduce yields and sometimes certain diseases reach epiphytotic proportions. Chemical control could help reduce some of these losses. Use of chemicals during normal years could control diseases that cause losses equal to 1% of the value of the crop.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.8		
No increase	0.8		
10% increase	0.9		
Recommended	-	1.0	1.0

ETIOLOGY AND EPIDEMIOLOGY OF RICE WEED PATHOGENS

RPA 208-K

PRIORITY: 4

SITUATION: The control of barnyardgrass with propanil has been dramatically successful from an agronomic standpoint. With chemicals applied to crops there is the question of residue buildup in soil that might affect subsequent crop plants, or fish. Likewise, propanil caused damage when it drifted onto sensitive neighboring crops such as soybeans or cotton. Propanil-insensitive species of grass and aquatic weeds such as Sprangletop (Leptochloa fasicularis), Christmas tree grass (Leptochloa panicoides), duck salad (Heteranthera sp.), and other weeds have not been adequately controlled with propanil or 2,4-D and are increasing in importance under the present rice culture regimes. Ordram and other herbicides are now available for use in rice culture. Such materials have different mechanisms and spectrums of activity and will control some of the weeds not controlled by propanil. Nevertheless, problems of residue and selectivity still will persist. Biological control of weeds with endemic or introduced bacterial or fungal diseases is an attractive alternative. Plant disease pathogens are a part of our normal environment and can be highly selective for specific hosts. None are infectious to man or animals. Many produce motile spores that would be ideally suited for control of aquatic weeds, and many can be produced commercially with existing fermentation facilities. Some work in this area is in progress and a notable example of preliminary success is the control of northern jointvetch in rice by an anthracnose fungus of the genus Colletotrichum.

OBJECTIVE: Identification and selection of organisms for potential control of weeds.

RESEARCH APPROACHES:

A. Survey diseases of weeds locally and in their native environment for virulent pathogens.

B. Select one or two facultative parasites or facultative saprophytes that affect weed seedlings.

C. Determine the conditions necessary for mass production of inoculum.

D. Examine environmental factors necessary for disease development, including the applications of nonselective, biodegradable, resistance-modifying chemicals.

E. Search for biodegradable toxins in culture filtrates that might be substituted for the intact organisms.

F. Coordinate with RPA 209 and other aspects of 208.

POTENTIAL BENEFITS: Economical control of weeds without hazard to man or animals. Avoidance of residue buildup in soils or other contamination of the environment. Benefits included in RPA 209-D.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.2		
No increase	0.2		
10% increase	0.2		
Recommended	-	0.5	0.5

CONTROL OF RING NEMATODES IN RICE

RPA 208-L

PRIORITY: 4

SITUATION: Predictions made 6½ years ago, that nematodes caused annual losses of 15% in Louisiana rice, have been verified and an empirical nematode-number rice-yield curve constructed for the purpose of refining prediction with reference to individual rice fields. Control opportunities are of three kinds: ryegrass culture, flooding and dry fallow, and chemical control with dichloropropene, which depends also on control of Cyperus esculentus L. (yellow nut sedge).

OBJECTIVES: To show rice growers the extent to which yields can be reduced in individual cases by ring nematodes and to attempt to reduce ring nematode numbers.

RESEARCH APPROACHES:

A. Predict rice yield losses due to ring nematodes in individual rice fields.

B. Conduct host and pathogenicity studies with ring nematodes Criconemoides onoensis Luc 1959 and Criconemoides sp. reedi type on both grassy weeds (grasses and sedges) and rice varieties.

C. Conduct biological studies of ring nematodes to find out the composition of populations (adult, eggs, larvae) with respect to different rice field-weed ecosystems and the number of generations of ring nematodes per season.

D. Conduct herbicide control tests with respect to yellow nut sedge and the superimposition of dichloropropene nematocide for ring nematode control in combination with reduced fertilizer levels.

E. Sample ryegrass fields to determine numbers of both ring nematode species carrying into the next year's rice crop.

F. Coordinate with RPA's 207 and 307.

POTENTIAL BENEFITS: Greatly increase rice yields.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.3		
No increase	0.3		
10% increase	0.3		
Recommended	-	0.5	0.5

IMPROVED EQUIPMENT FOR THE APPLICATION OF CHEMICALS TO RICE FOR THE CONTROL OF DISEASES

RPA 208-M

PRIORITY: 4

SITUATION: The standard methods of applying chemicals for control of diseases of rice have been to treat seed in a slurry and use foliar applications as protectants against infection by fungi. Newer theories of chemical control involve (1) low volume applications of materials of extremely small particle and/or droplet size, (2) granular applications of systemic fungicides to soil that protect against infection from the seedling stage to maturity, and (3) surfactants and carriers that increase the effectiveness of materials. Still newer methods of plant disease control that require application equipment involve bacteria that produce chemicals antagonistic to the growth of fungi. Application of live bacteria to plants and plant seed would require heretofore unforeseen methods and precautions but might control diseases of plants where inroads of control have never been achieved before. Equipment advances will become a reality when fundamental evidence shows that the new methods of application are effective. Chemicals could still play a significant role in the control of panicle blight of rice and diseases of the crown and lower stem.

OBJECTIVE: To devise new, more effective methods of applying chemicals to control diseases of rice.

RESEARCH APPROACHES:

A. Try new methods of application of chemicals that could increase their activity over that achieved by standard methods of application.

B. Use granular fungicides for treatment of soil to try to control stem rot and other lower stem diseases of rice.

C. Obtain experimental live bacterial preparations antagonistic to fungi for trials to control foliar diseases and panicle blight of rice.

D. Consult with agricultural engineers to devise and modify application equipment to meet the needs of any new methods.

E. Coordinate with RPA's 207, 308, and other aspects of 208.

POTENTIAL BENEFITS: To use new methods of applying chemicals of proven value as well as new materials in the most efficient manner possible. Improved control of rice diseases coordinated with economical practices could result in profits equal to 1% of the crop.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.0		
10% increase	0.0		
Recommended	-	0.2	0.2

Summary of Research Problem Area 209 - Control of Weeds of Field Crops

Problem	Priority	SMY's Current	No Increase	10% Increase	Recommended 1979	Recommended 1984
A. Evaluate New Herbicides and Improve Safety and Efficacy of all Herbicides	1	0.9	0.8	1.0	1.5	1.5
B. Develop Integrated Weed Control Systems to Control Different Complexes of Weeds in Rice	2	1.0	0.8	1.1	1.5	1.5
C. Comparative Biology, Physiology, and Ecology of Specific Weeds in Rice	2	0.5	0.5	0.6	1.0	1.0
D. Control of Weeds by Improved Cultural, Water-Management and Cropping-System Practices	2	0.5	0.5	0.6	1.0	1.0
E. Survey and Evaluation of Diseases, Insects, and Other Pests for Potential Biocontrol of Weeds	3	0.0	0.1	0.0	0.5	1.0
F. Development of Bioherbicides and Other Biocontrol Agents for Weed Control in Rice	3	0.1	0.1	0.1	0.5	1.0
G. Improved Methods and Equipment for Applying Herbicides	3	0.0	0.1	0.1	0.5	0.1
H. Mechanism of Herbicide Action	4	0.1	0.2	0.1	0.5	0.5

EVALUATE NEW HERBICIDES AND IMPROVE SAFETY AND EFFICACY OF ALL HERBICIDES

RPA 209-A

PRIORITY: 1

SITUATION: Several herbicide treatments, used in combination with other practices, effectively control some of the weeds that infest rice. However, most herbicides have significant limitations in use because of low selectivity, poor weed control in adverse environments, or drift hazard to adjacent susceptible crops. For example, herbicides applied preplant or preemergence may injure rice unless rigid restrictions are made with respect to techniques of water management and seeding. Herbicides, now used postemergence for control of grass weeds, are usually effective only if applied to young, actively growing weeds, and some provide no control of weeds that germinate after application. Soybeans, cotton, prunes, and certain vegetable and orchard plants are particularly sensitive to several of the postemergence herbicides. Additional information is needed on persistence and movement of herbicides in soil, water, and plants. The best available herbicides and combination treatments are only marginally effective against algae, emersed and submersed aquatic weeds, red rice, sprangletop, dayflower, alligatorweed, morningglory, smartweed, and perennial grasses and sedges. These resistant weeds and barnyardgrass are now the primary targets of research.

OBJECTIVE: To obtain information on how new herbicides, formulations, mixtures, and use of older chemicals can be used to obtain better control of weeds and reduce hazards and problems now encountered.

RESEARCH APPROACHES:

A. Evaluate new herbicides, formulations, mixtures, combinations, adjuvants, antidotes, and new methods of applying older herbicides for selective control of major problem weeds in each rice production area and region.

B. Determine minimal quantities of herbicides required for effective, economical, safe weed control by using mixtures, combinations, adjuvants, antidotes, and new application techniques.

C. Investigate the technique of applying herbicides by injection into irrigation water as it enters the field, and explore the efficacy of other new techniques of applying herbicides.

D. Investigate factors which influence penetration, absorption, and translocation of herbicides in plants to improve activity and selectivity.

E. Conduct research to characterize persistence and movement of herbicides in soil, water, and plants.

F. Develop techniques for controlling movement and persistence of herbicides in soil and in irrigation water, and study ways of controlling movement of herbicides from target fields.

G. Coordinate with research of RPA's 207, 208, 307, 308, and other aspects of 209.

POTENTIAL BENEFITS: Increase yields and improve quality of rice, reduce losses caused by herbicide damage to nontarget crops, ensure optimum use of land and irrigation water by methods safe for rotational crops that follow rice, and reduce costs of production. Benefits from 209-A would contribute to 209-B at approximately 20% of the total benefits from 209-B.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.9		
No increase	0.8		
10% increase	1.0		
Recommended	-	1.5	1.5

DEVELOP INTEGRATED WEED CONTROL SYSTEMS TO CONTROL DIFFERENT COMPLEXES OF WEEDS IN RICE

RPA 209-B

PRIORITY: 2

SITUATION: Algae, grass, broadleaf, and sedge weeds infest rice fields. Both annuals and perennials, which grow in terrestrial and aquatic sites, are problems. The terrestrial weeds germinate in moist soil, and most tolerate flooding after emergence; the aquatic weeds germinate and grow in flooded soil. Weed species, which make up the total weed complex, in any one field vary among rice growing regions and areas; they often differ between adjacent fields. Methods that control one complex of weeds may fail completely in another field that is infested with a different weed complex.

Weeds reduce yields and quality, use fertilizer and water that otherwise would be available to the rice crop, harbor insects, diseases, and nematodes, and generally increase the cost of producing and harvesting rice. The presence of some weed species often requires specific irrigation and fertilizer practices. Frequently the cultural practices required to control weeds are injurious to rice.

In 1973 U.S. farmers treated an estimated 90% of their rice with herbicides at an estimated cost of $14/A, or $31 million on 2.2 million acres of rice. This compares with 82% treated in 1968 at a cost of $11/A. Weeds cost rice farmers an estimated 15% of the crop value in lowered yield and quality and an additional 5 to 10% of the crop value in costs of weed-control inputs.

Current combinations of weed-control treatments provide relatively effective control of barnyardgrass, hemp sesbania, northern jointvetch, mexicanweed, and many other annual broadleaf, grass, and sedge weeds. They do not, however, adequately control emersed and submersed aquatic weeds, red rice, sprangletop, dayflower, morningglory, and certain perennial species including alligatorweed, paspalums, bulrushes, and arrowheads. The best approaches for effective, practical control of different complexes of weeds are to develop weed-control systems combining two or more components to include cultural practices, crop rotations, herbicides, and biological controls. Herbicide programs which combine two or more herbicides in mixtures or sequential treatments are frequently desirable. Research is being conducted to improve the efficacy of treatments within the weed-control system and to develop improved combination treatments. Success of this research would improve weed-control systems by combining treatments to control specific weed complexes associated with different micro-environments and different regions and areas of the U.S.

Herbicidal, chemical, and biological agents for weed control in rice are frequently not economically feasible for private agencies to develop. The required data and information for registration and ultimate use of weed-control agents on rice, which consumes only about 2 million acres each year in the U.S., often cost more than industry can afford when considering the returns from use in a small-acreage crop. In addition, ecological changes of weed populations, resistant to recommended herbicides, have occurred in rice. The development of hard-to-kill weeds may begin only on a relatively small acreage in specific rice growing areas. If new herbicides are not developed to control these hard-to-kill weeds, they will cause losses in yield and quality in specific areas and may spread to other areas before control agents can be economically registered and used by industry. Hence, if federal and state agencies could help develop information that is now obtained by private industry to register control agents for weed problems in small-acreage situations, farmers would have access sooner to more effective weed-control treatments.

OBJECTIVES: (1) To develop improved components of weed-control systems for control of various weed complexes common to southern and western regions of the U.S. Specifically the goal is to reduce the competitive effects of weeds so that production inputs, such as varieties, fertilizers, water, and others, can be utilized with maximum efficiency for production of high-yielding, good-quality rice. (2) To coordinate the development of efficient, practical herbicidal, chemical, and biological control agents with private industry, the Environmental Protection Agency, and other federal and state agencies. Specifically the goal is to select effective chemical or biological treatments and develop the required information, through the cooperative effort of responsible private and public agencies, for registration and use in weed-control programs for rice.

RESEARCH APPROACHES:

A. Investigate the ecological effects of different combinations of cropping systems, herbicide rotations, cultural practices and biological controls on natural weed infestations.

B. Study different combinations of treatments for efficacy against specific weed complexes associated with each area and region of rice production.

C. Study combinations of weed-control components selected for performance under different environmental and cultural practices of each rice production region of the U.S.

D. Coordinate the development of efficient, practical chemical and biological treatments with private industry, the Environmental Protection Agency, and other federal and state agencies.

E. Coordinate with research in RPA's 207, 208, 307, 308, 309, and other aspects of 209.

POTENTIAL BENEFITS: Increased yields, improved quality, and lowered cost of production. Reasonably successful efforts would reduce losses in yields and quality by an amount equal to an estimated 10% of the potential yield of rice. Improved weed control methods developed by this research would reduce the cost of weed control by an estimated 3% of the crop value.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.0		
No increase	0.8		
10% increase	1.1		
Recommended	-	1.5	1.5

COMPARATIVE BIOLOGY, PHYSIOLOGY, AND ECOLOGY OF SPECIFIC WEEDS AND RICE

RPA 209-C

PRIORITY: 2

SITUATION: Weeds that infest rice fields include annual and perennial species of terrestrial, aquatic, and amphibious plants. Because little is known about the biology, physiology, and ecology of aquatic rice-field weeds, research is needed to develop such information so that any inherent weaknesses of weeds could be exploited by use of cultural, chemical, or biological controls, or superior traits of improved rice varieties could be used advantageously. Development of fundamental knowledge on competitiveness of weeds and rice and requirements for germination, establishment, growth, and reproduction of aquatic weeds could improve weed-control practices. Because some rice varieties have a greater tolerance than others to certain herbicides, research to compare tolerance of varieties to herbicides would reduce crop injury and improve grain yields.

OBJECTIVE: To determine and exploit differences in the biology, physiology, and ecology of problem rice-field weeds and rice as a means of improving current control practices, developing new control treatments, reducing weed infestations, and improving rice tolerance to herbicides.

RESEARCH APPROACHES:

A. Study the requirements for germination, growth, establishment, and reproduction by propagules of problem weeds and rice, and evaluate control methods using these requirement differences to provide better control.

B. Investigate ecological and economic aspects of competition between rice and selected major weeds.

C. Determine the possibility of increasing the competitive advantage of rice through variety selection and improved cultural practices.

D. Study the differential tolerance of major rice varieties and advanced genetic lines to herbicides.

E. Coordinate with research in RPA's 207, 208, 307, and other aspects of 209.

POTENTIAL BENEFITS: Increased yields and quality of rice through better weed control from use of improved cultural and management practices, and possible reduction in use of herbicides. Improved tolerance of rice varieties to herbicides should result.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.5		
No increase	0.5		
10% increase	0.6		
Recommended	-	1.0	1.0

CONTROL OF WEEDS BY IMPROVED CULTURAL, WATER-MANAGEMENT, AND CROPPING-SYSTEM PRACTICES

RPA 209-D

PRIORITY: 2

SITUATION: Although water management is widely used to complement other methods of controlling weeds in rice, opportunities exist for greatly improving control of weeds through refinements in water management, changes in seedbed preparation techniques, changes in use of fertilizers, altering seeding methods and times, use of land fallowing, use of better cropping systems, and adjustments in other cultural practices. Red rice, alligatorweed, algae and other aquatic weeds, and perennial grasses and sedges may be controlled by changing present cultural management and cropping systems. For example, red rice infestations can be reduced by the use of (1) stale-seedbed techniques, (2) mechanically working the flooded soil before seeding, (3) water seeding rice combined with holding the water on the field for about 4 weeks after seeding, or (4) by rotating specific upland crops with rice. Nonchemical methods may be effective approaches to control weed species resistant to herbicides or to make resistant weeds more susceptible to herbicide treatments.

OBJECTIVE: To improve seedbed preparation, water management, seeding, cropping, and other cultural practices for control of weeds in rice.

RESEARCH APPROACHES:

A. Investigate new techniques in water management to provide better direct control of weeds or to make weeds more susceptible to other control methods.

B. Evaluate the application of seeding techniques, such as water seeding, to control weeds that are not susceptible to herbicides.

C. Study new methods of seedbed preparation, such as stale-seedbed techniques, to control hard-to-kill weeds, such as red rice and perennial grass, broadleaf, or sedge weeds.

D. Evaluate the timing and placement of fertilizer applications to favor rice growth at the expense of weed growth.

E. Characterize the location of viable weed seed or other propagules in soil and attempt to develop techniques, including water and soil management practices, to control their germination, emergence, and viability.

F. Coordinate with research in RPA's 207, 208, 307, 308, and other aspects of 209.

POTENTIAL BENEFITS: Decreased production costs, reduced losses in yield and quality due to weeds, and fewer problems associated with the use of herbicides to control hard-to-kill weeds.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.5		
No increase	0.5		
10% increase	0.6		
Recommended	-	1.0	1.0

SURVEY AND EVALUATION OF DISEASES, INSECTS, AND OTHER PESTS FOR POTENTIAL BIOCONTROL OF WEEDS

RPA 209-E

PRIORITY: 3

SITUATION: The concept of using an endemic pathogen to control its weed host has been successfully demonstrated in rice plots and fields with one host-parasite combination, i.e. Colletotrichum gloeosporioides F. sp. aeschynomene on northern jointvetch. Nearly every other troublesome weed of rice is the host for one or more known pathogens that incite diseases sporadically in natural populations. These pathogens vary greatly in levels of parasitism or virulence, specificity, ability to sporulate in artificial culture, and environmental requirements for infection, incubation, and pathogenesis. Insects, also, control specific weeds. Alligatorweed beetles have successfully controlled alligatorweed, a problem weed in rice fields. Initiation of surveys could find new insects or other pests that attack problem rice-field weeds. Many of the problems encountered with chemical herbicides, such as toxicity to man and wildlife, residues in soil and water, and injury to non-target crops from spray drifts, may be avoided if naturally occurring, living pathogens or specific insects or other pests are substituted for chemicals.

OBJECTIVE: To locate, identify, and evaluate fungal pathogens that have potential as biocontrol agents of specific weeds, insects, and other pests of rice.

RESEARCH APPROACHES:

A. Isolate pathogens in pure culture, selecting strains for sporulating ability.

B. Prove pathogenicity and degree of specificity in greenhouse tests.

C. Determine optimum environmental conditions for pathogenesis in humidity-controlled growth chambers.

D. Develop media and culture conditions for large-scale spore production.

E. Challenge mammals and cold-blooded animals for mycotoxicosis, mycosis, or sensitization.

F. Evaluate for efficacy in field plots.

G. Collect, press, and store weed disease specimens annually for deposit in the National Fungus Collection and updating Agriculture Handbook 165 - Host Index of Plant Disease.

H. Survey for insects that attack rice-field weeds and conduct research to determine their specificity, growth, and potential use for weed control in rice.

I. Coordinate with research in RPA's 207, 208, 307, 308, and other aspects of 209.

POTENTIAL BENEFITS: Improve weed control and rice yields and quality, reduce use of chemical herbicides, prevent damage to rice and non-target crops, and avoid persistence of chemicals in soil, water and crops.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.1		
10% increase	0.0		
Recommended	-	0.5	1.0

DEVELOPMENT OF BIOHERBICIDES AND OTHER BIOCONTROL AGENTS FOR WEED CONTROL IN RICE

RPA 209-F

PRIORITY: 3

SITUATION: The concept of using an endemic fungal disease as a biological herbicide has been tested during the past four growing seasons and proved successful in restricted field plots and limited acreage in grower fields. It now remains to be examined on a larger scale to assess its efficacy and adaptability to commercial-scale operation. As new pathogens and insects that control rice-field weeds are discovered, research will be initiated to develop methods of production, storage, and dispersal for practical weed control.

OBJECTIVE: To determine the feasibility of using endemic fungal diseases or other plant diseases, insects, and biocontrol agents for controlling northern jointvetch and other weeds in rice.

RESEARCH APPROACHES:

A. Scale-up laboratory spore production techniques to batch-type fermentation, optimizing inoculum to volume ratio, medium composition and pH, temperature, aeration, and agitation for economic production of spores.

B. Evaluate human and environmental safety of the fungus with special emphasis on possibility of mycotoxin production, mycosis, or sensitization to the fungus.

C. Develop and compare suitable procedures for packaging and storage of spores on a commercial scale in normal trade channels.

D. Test efficacy in the field under diverse environmental, cultural, and agronomic conditions.

E. Study persistence of the fungus in rice field environments.

F. Analyze the use of the bioherbicide as a component of a weed-control program and compare cost of the bioherbicide with alternate weed-control components.

G. Evaluate and develop new pathogens, insects, and other biocontrol agents discovered in 209-F for potential control of rice-field weeds.

H. Coordinate with research in RPA's 207, 208, 307, 308, 316, and other aspects of 209.

POTENTIAL BENEFITS: Selective control of northern jointvetch or other weeds with effective pathogens or other biocontrol agents without damage to adjacent crops from drifts of sprays, or damage to rice by untimely application of phenoxy or other herbicides. Reduce hazard to environment, the most important being lack of harmful residues in soil, water, and crops. Principles developed on spore production, packaging, storage, transport, and dispersal of the fungus that controls northern jointvetch would benefit the development of other bioherbicides or other biocontrol agents.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.1		
No increase	0.1		
10% increase	0.1		
Recommended	-	0.5	1.0

IMPROVED METHODS AND EQUIPMENT FOR APPLYING HERBICIDES

RPA 209-G

PRIORITY: 3

SITUATION: Herbicides are generally applied to rice fields by aircraft. Frequently, herbicides drift from the target field and damage nearby susceptible crops. Improved methods and equipment for application of herbicides could increase the amount of pesticide deposited on target rice fields, and thus lower required rates, improve weed control, and reduce injury to non-target organisms. Research with low-drift formulations, granular herbicides, coating rice seed with herbicides, formulations of herbicides and devices for metering herbicides into water as fields are flooded, and new types of equipment could improve efficacy and safety of herbicides. Herbicides applied with other agrichemicals such as fertilizers, insecticides, fungicides, nematicides, etc., can reduce the number of trips across rice fields and thus reduce costs and conserve energy.

OBJECTIVE: Develop improved methods and equipment to control weeds more effectively, reduce spray drift from target rice fields, lessen environmental contamination, reduce costs, and conserve energy.

RESEARCH APPROACHES:

A. Develop herbicide formulations for aerial application that reduce spray drift and improve efficacy of herbicides.

B. Develop sprayers that emit uniform sized droplets without producing fine particles more susceptible to drift.

C. Develop equipment, formulations, and adjuvants for sprays to reduce carrier evaporation and increase the amount of spray deposited on target fields.

D. Research methods of coating rice seed with herbicides for application during seeding.

E. Study methods of applying herbicides with other agrichemicals such as fertilizers, insecticides, and other pesticides.

F. Develop granular formulations and equipment for distribution of granules to improve efficacy and safety of herbicides.

G. Improve methods of studying spray drift from aircraft dispersal.

H. Determine the effects of equipment and environment on spray drift and distribution patterns.

I. Coordinate with research in RPA's 207, 208, 307, 308, and other aspects of 209.

POTENTIAL BENEFITS: Reduce spray drift and damage to adjacent susceptible crops, lower rates of application, and improve weed control and safety of herbicides.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.1		
10% increase	0.1		
Recommended	-	0.5	0.5

MECHANISM OF HERBICIDE ACTION

RPA 209-H

PRIORITY: 4

SITUATION: Rice, because it germinates and grows in flooded soil, differs greatly from other agronomic crops. These differences present both advantages and disadvantages related to use of herbicides. Both rice and weeds that infest rice may respond differently to herbicides than do crops or weeds growing in nonaquatic environments. Consequently, considerable existing mechanism research conducted with upland crops and weeds does not apply to rice. Currently preplant, preemergence, and postemergence herbicide treatments are used to control weeds in rice. These treatments frequently fail to control weeds adequately and occasionally damage rice. A better understanding is needed of the principles of herbicide action for plants growing in an aquatic environment and of physiological differences of rice and weeds. Lack of such information limits level of selectivity and weed control.

OBJECTIVES: To determine the mode of action and basis of selective toxicity of herbicides as related to differences in physiology and biochemistry of rice and specific weeds growing in upland and aquatic environments, and to use this information to increase efficacy and safety of herbicides in weed-control programs for rice.

RESEARCH APPROACHES:

A. Determine the effects of herbicides on essential metabolic systems in major weeds and in rice.

B. Study the influence of seeding and water-management practices on the response of rice and weeds to herbicides.

C. Explore the influence of natural variations in microenvironments on the response of rice and weeds to herbicides.

D. Determine how insecticides, fungicides, growth regulators, antidotes, and other chemicals alter the action of herbicides in rice and weeds.

E. Develop and test theories based on results of 209-A through -H to explain herbicide action and selectivity and to improve techniques of using herbicides.

F. Coordinate with research of RPA's 207, 208, 307, and other aspects of 209.

POTENTIAL BENEFITS: Increased efficacy of herbicides on weeds, reduced injury of rice by control treatments, and lowered residues of herbicides in food and feed products will be obtained.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.1		
No increase	0.2		
10% increase	0.1		
Recommended	-	0.5	0.5

Summary of Research Problem Area 307 - Improvement of Biological Efficiency of Field Crops

Problem	Priority	SMY's				
		Current	No Increase	10% Increase	Recommended 1979	Recommended 1984
A. Rice Improvement Through Genetics and Breeding	1	6.4	6.4	7.0	12.0	12.0
B. Chemistry of Flooded Soils	2	1.3	1.3	1.4	2.5	2.5
C. Nutrition and Fertilization of Rice	2	3.9	3.9	4.3	5.5	5.5
D. Water Management	3	0.8	0.9	1.0	1.5	1.5
E. The Role of Microclimate in Rice Production	3	0.3	0.5	0.6	1.5	1.5
F. Soil Management	4	0.2	0.2	0.2	0.7	0.7
G. Crop Management	4	1.3	1.0	1.1	1.8	1.8

RICE IMPROVEMENT THROUGH GENETICS AND BREEDING

RPA 307-A

PRIORITY: 1

SITUATION: The development and use of improved rice varieties resulting from genetics and breeding research has contributed greatly to the dramatic increases in rice yields. Factors under genetic control which can be further improved through breeding include: plant type, height, maturity, and other agronomic characteristics; response to and efficient use of fertilizer; resistance or tolerance to diseases, insects, and adverse environmental conditions; milling, cooking, and processing characteristics, and nutritive (protein and amino acid) content. There is an urgent need to broaden the genetic base of U.S. rice varieties through an accelerated breeding program using available sources of diverse germplasm. Before they are lost to posterity, additional sources of germplasm should be collected in all possible areas of the world from which existing exotic and indigenous types have not yet been collected for use. Further detailed research should be carried out to determine which plant characteristics are most closely associated with greater efficiency in converting solar energy to ultimate increased grain yields. Effective and efficient methods of screening for these characteristics are urgently needed.

OBJECTIVE: Develop through basic genetic studies and breeding, rice varieties with higher field and mill yields, and that have desired agronomic, processing, and cooking characteristics, improved nutrient content, and increased resistance to production hazards.

RESEARCH APPROACHES:

A. Improve the level and stability of grain and mill yields by increasing fertilizer responsiveness and resistance to lodging, diseases, insects, and other production hazards; improve processing, cooking, and other characteristics through appropriate breeding methods and the release of improved cultivars.

B. Reduce the genetic vulnerability of commercial rice varieties by broadening their genetic base through the use of available sources of diverse germplasm. All existing exotic and indigenous *Oryza* germplasm not now in the USDA World Collection should be collected and made available to rice breeders in the U.S. Improved techniques and intensified coordination of efforts are needed to expand the screening, maintenance, and utilization of the USDA World Collection and breeding materials for resistance to important production hazards, and for alternate sources of genes for short stature and glabrous (smooth) plant parts.

C. Conduct basic studies to improve solar energy conversion by rice; determine relative efficiency of present cultivars; study relationships between photosynthetic efficiency and plant height, leaf characteristics, grain/straw ratios, carbohydrate translocation, and other plant characteristics. Locate types with greater efficiency and transfer this to adapted types by means of improved screening and breeding procedures.

D. Through cooperative research, determine optimum cultural practices for new rice varieties prior to release for commercial production.

E. Develop improved breeding methods and procedures and expand use of multiple-generations per year to gain time and efficiency.

F. Continue basic research on developing both genetic and cytoplasmic male sterility systems for use in facilitating crossing; include studies on pollen production and outcrossing. Make further studies seeking greater levels of hybrid vigor and possible methods for commercial use.

G. Develop improved techniques for studying the effect of microenvironmental factors on the growth and health of rice plants, and for screening specific rice genotypes or varieties for suitability to particular environmental conditions and management practices, such as emergence through water, seedling vigor, and varietal resistance to low temperature during the entire life cycle.

H. Coordinate with RPA's 103, 105, 207, 208, 209, 214, 308, 309, 405, 406, and 408.

POTENTIAL BENEFITS: Identifying the genetic, physiologic, and morphologic determinants of grain yield and developing suitable screening techniques for these determinants would greatly enhance development of higher yielding types. This should bring about increases in grain yields of 20 to 40%. Collection of all possible remaining exotic or indigenous types of Oryza not already available should provide valuable germplasm for use as needed. Added coordination of the screening and utilization of the USDA World Collection of rice germplasm would provide a broader genetic base for new and improved commercial varieties of rice; this should greatly increase the resistance to production hazards and decrease the need for chemical pesticides. Major benefits can be derived from increased personnel, equipment and facilities, and closer coordination of efforts in the multiple research areas which are directly

related to rice breeding. As an example, experimental varieties and breeding lines already are available which average 25% (2 percentage points) higher in protein content. Intensifying this research could appreciably shorten the time required to develop high-yielding "high-protein" varieties with sufficient resistance to lodging and disease to make them commercially acceptable to both growers and consumers. Development of improved scented and other special use varieties and extremely high yielding "industrial" types could greatly expand domestic use of rice.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	6.4		
No increase	6.4		
10% increase	7.0		
Recommended	-	12.0	12.0

CHEMISTRY OF FLOODED SOILS

RPA 307-B

PRIORITY: 2

SITUATION: The anaerobic and chemically reduced root zone of the soil in which lowland rice is grown differs greatly from the root zone of a well-drained soil. The reduced conditions in rice soils affect the growth of the rice plant and the availability of several plant nutrients. A better understanding is needed of how the rice plant is affected by reducing conditions and how native and added plant nutrients react in waterlogged soils. We also need to know the chemical processes taking place in waterlogged soils and how these processes affect the growth of the rice plant and the availability of plant nutrients.

OBJECTIVE: To obtain basic information on those chemical processes taking place in soils as a result of waterlogging that are of importance to the growth and nutrition of the rice plant.

RESEARCH APPROACHES:

A. Study the effect of waterlogging, temperature, and time after nitrogen application on denitrification losses of nitrogen from different soil types.

B. Determine how waterlogging influences the role of organic matter and other factors in the soil chemistry of micronutrient elements and how this influences micronutrient uptake by rice plants.

C. Determine the effect of waterlogging on changes in both inorganic and organic chemical systems in the soil.

D. Characterize the reactions that occur between components of different oxidation-reduction systems in waterlogged soils and determine the effect of these reactions on the nutrition of the rice plant.

E. Study the effect of reduced chemical systems in waterlogged soils on the availability of plant nutrients to the rice plant.

F. Determine the production of substances in waterlogged soils that are toxic to the rice plant and ascertain means of correction. Also determine the effect of straw incorporated in the soil on the production of toxic substances.

G. Measure the effect of different intensities of reduction caused by waterlogging on growth and development of the rice plant.

H. Determine the factors involved in fixation and release of phosphate in waterlogged soils.

I. Measure long-term effects of waterlogging on physiochemical changes occurring in soils which may influence soil productivity.

J. Coordinate with other research under RPA 307.

POTENTIAL BENEFITS: Improved growth and yield of rice; improved utilization of plant nutrients. A better understanding of the chemical environment of the rice plant will result in increased yields through improved nutrition and more effective fertilization.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.3		
No increase	1.3		
10% increase	1.4		
Recommended	-	2.5	2.5

NUTRITION AND FERTILIZATION OF RICE

RPA 307-C

PRIORITY: 2

SITUATION: Fertilization practices for rice differ from those for other crops because of physiological differences in the rice plant and also because some plant nutrients are in a different form in a flooded soil than in a well-drained soil. Nitrogen nutrition and fertilization of rice are especially critical since nitrogen is generally deficient in rice soils and a large amount of applied nitrogen (about 120 lb/A total) is needed by the crop for maximum production. Present United States varieties are limited in the amount of nitrogen they can utilize due to the danger of lodging. Development of shorter, stiff-strawed varieties which are being actively sought by plant breeders will require additional studies on the optimum amounts of fertilizer nutrients, especially nitrogen. Unlike nitrogen, which is subject to increased loss as a result of flooding, phosphate is more available under waterlogged soil conditions than under well-drained conditions. Certain micronutrients - iron and manganese, for example - are usually increased in availability by waterlogging, sometimes to the point of toxicity, while the availability of others may be decreased by waterlogging. Information on the reactions of major nutrients and micronutrients in well-drained soils is of little value in predicting their reactions in waterlogged soils. Growers currently cannot determine the optimum rate of fertilizer that should be applied. Development of methods to evaluate the nutritional requirements, especially for nitrogen, is urgently needed.

OBJECTIVES: To determine the yield response of both present and new varieties to various forms of plant nutrients. To develop an accurate method of soil and tissue analyses to be used by growers in determining fertilizer requirements and to identify nutrient deficiencies.

RESEARCH APPROACHES:

A. Find out why efficiency of urea varies so greatly from field to field and from one crop year to the next as compared with ammonium sulfate.

B. Describe the soil and physiological (both root and leaf) mechanisms which cause an apparent zinc deficiency in a flooded rice crop.

C. Develop a complete nitrogen budget for flooded soil planted to rice, including how nitrogen is gained, lost, and utilized by both soil and rice plants.

D. Measure the yield response of new and existing varieties of rice to both major and micronutrients under different soil and climate conditions and correlate with soil test values.

E. Investigate various methods of placement and incorporation of plant nutrients in the soil to obtain maximum yield response.

F. Evaluate new forms of fertilizers and new methods of controlled release of fertilizer nutrients to improve the response of rice to plant nutrients.

G. Determine the best fertilization system to use for ratoon or double-cropped rice (two crops harvested from one planting).

H. Study the effect of fertilization on amino acid composition and protein content of rice.

I. Devise treatments for soils with saline, alkaline, or calcareous soil conditions that occur naturally or as a result of poor quality irrigation water.

J. Develop methods of soil analysis and plant tissue analysis by which reliable predictions of fertilizer requirements can be made.

K. Determine the effect of biocides on chemical processes in waterlogged soils.

L. Evaluate the use of leguminous green-manure crops as an alternate source of nitrogen for rice production.

M. In cooperation with RPA 307-A, develop varieties that are insensitive to micronutrients, high soil pH, and high salt concentrations.

N. Cooperate with RPA 307-A to determine why some varieties require less N fertilizer for maximum grain yield.

O. Study the influence of applying lime or sulphur to a soil on the uptake of all micronutrients by a flooded rice crop.

POTENTIAL BENEFITS: Increased yield and quality of the crop and/or decreased cost of production.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	3.9		
No increase	3.9		
10% increase	4.3		
Recommended	-	5.5	5.5

WATER MANAGEMENT

RPA 307-D

PRIORITY: 3

SITUATION: Although keeping the rice field flooded is recognized as an essential practice in lowland rice culture, only a limited amount of research has been done on determining the benefits to be derived from flooding and on improving the efficiency of water use. Water supplies are likely not to be as plentiful in the future as in the past and information is needed on methods of improving the efficiency with which water is used.

OBJECTIVE: To develop methods by which the efficiency of irrigation water usage can be improved.

RESEARCH APPROACHES:

A. Devise methods of improving the quality of irrigation water before it is applied to the field.

B. Determine if effective chemical weed control and maintenance of an adequate supply of available water without submergence of the soil can replace flood irrigation.

C. Determine the critical water requirements of rice at different stages of plant development so that irrigation practices can be established for situations of water shortage.

D. Measure the effect of production resource chemicals on quality of effluent water and soil.

E. Compare season-long flooding of rice fields with intermittent periods of flooding.

F. Determine the optimum depth of floodwater for different varieties, especially shorter plant types.

G. Study overwinter flooding of rice fields as a means of conserving superior quality irrigation water, especially where water quality is a problem. Also study effect of overwintering on yield of following crops, both rice and rotation crops.

H. Determine the effect of better management of irrigation water on the utilization of plant nutrients. Specifically, this will involve measurement of nutrient loss caused by draining.

I. Determine the effect of industrial wastes in water on the growth and yield of rice and on soil properties.

J. Determine the physiological basis for yield reduction in non-flooded rice.

K. Find out if the use of surface water poses a threat of gradual build-up of any one element, especially sodium, in soils planted to rice.

L. Coordinate with research under RPA 209 and other aspects of 307.

POTENTIAL BENEFITS: More efficient use of water and/or higher yields.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.8		
No increase	0.9		
10% increase	1.0		
Recommended	-	1.5	1.5

THE ROLE OF MICROCLIMATE IN RICE PRODUCTION

RPA 307-E

PRIORITY: 3

SITUATION: The microclimate in a rice field is unique among cultivated crops because the soil is flooded during most of the growing season. This obviously causes high relative humidities within and above the rice canopy and also may influence many other environmental elements such as air and soil temperature, light, carbon dioxide concentration and net radiation. These factors in turn affect the rice plant directly by governing photosynthesis rate, respiration, starch accumulation, pollination and seed maturation, and indirectly through their influence on disease and insect outbreaks and buildups. The flooding and draining of rice fields therefore is an effective means of manipulating the microclimate of the crop to a greater extent and to more timely advantage than is possible with other crops. Previous investigations and observations indicate that nighttime temperatures in the 50 to 55 degree F. range during flowering in rice result in greatly reduced seed set and yield. Other environmental and/or physiological conditions in absence of low temperature also cause low seed set but the exact conditions are not known. Abrupt temperature changes also appear to affect seed set, grain yields and quality. Some microclimate studies have been made in the orient on hand-transplanted rice but only preliminary, minimal instrumented studies have been made on rice grown in our direct seeding system of culture.

OBJECTIVE: To characterize the microclimate in rice fields during the growing season and relate each facet to growth and pollination processes in the plant and determine the sensitivity of each facet to climatological changes or modification of cultural practices.

RESEARCH APPROACHES:

A. Establish the relationships which seem to exist between climatological factors and the efficiency with which rice plants utilize nitrogen fertilizer.

B. Determine the profile of temperature, humidity, light, and net radiation in rice plots throughout the growing season with several varieties and cultural regimes with intensive characterization of growth, pollination, diseases, and insect buildup in the same plots.

C. Assimilate from existing climatological and agronomic data the climatological or meteorological factors that appear to affect growth and pollination of rice most substantially.

D. Determine insofar as possible the effect of abrupt temperature changes on seed set, grain yields, and quality.

E. Select varieties, row spacing, water management practices, etc., to optimize the microclimate for plant growth, maximum yield, and quality as predicted by long- and short-range weather forecasts.

F. Coordinate with research in RPA's 207, 208, 209, 308, 405, and other aspects of 307.

POTENTIAL BENEFITS: Growers could make management decisions based on long-term probabilities rather than from memory of the preceding one or two seasons. Breeders could select varieties with maturity dates and growth characteristics to take maximum advantage of the climate of a particular region. Disease and insect control measures could be more effectively applied. Fertilizer application could be timed for most efficient uptake and utilization.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.3		
No increase	0.5		
10% increase	0.6		
Recommended	-	1.5	1.5

SOIL MANAGEMENT

RPA 307-F

PRIORITY: 4

SITUATION: The development of larger tractors and implements, effective weed control practices, precision leveling of rice fields, and water seeding of rice by airplane have changed the traditional methods of tillage and seedbed preparation A smooth, well-worked seedbed may not be as essential as in the past. Adequate power is now available so that the soil can be worked deeper.

OBJECTIVE: To investigate various methods of tillage and seedbed preparation for rice utilizing the latest developments in tillage equipment, fertilizer application, weed control, seed treatment, and seeding methods.

RESEARCH APPROACHES:

A. Evaluate energy requirements for the most frequently used soil management practices and determine which are the most efficient.

B. Develop and evaluate effective materials which can be applied with ease and accuracy for the management of high pH soils.

C. Compare the effectiveness of various tillage tools for plowing, seedbed preparation, and straw incorporation. Measure their effect on stand of crop and yield.

D. Compare conventional methods of seedbed preparation with minimum tillage, no tillage methods, and substitution of chemicals for tillage.

E. Study land preparation and fertilizer application in the fall with overwinter flooding as a method of conserving nitrogen and irrigation water.

F. Determine the effect of various rotations, including growing rice every year and straw incorporation, on the soil organic matter content and soil structure.

G. Determine what cultural practices are needed to successfully seed rice on heavy clay soils.

H. Coordinate with research under RPA 308 and other aspects of 307.

POTENTIAL BENEFITS: Increase yields and/or lower land preparation costs.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.2		
No increase	0.2		
10% increase	0.2		
Recommended	-	0.7	0.7

CROP MANAGEMENT

RPA 307-G

PRIORITY: 4

SITUATION: Recent developments in weed control, fertilization, and seeding practices have caused changes in the traditional methods of management of the rice crop. Most present methods of management were based on the use of small amounts of fertilizer with the crop obtaining a significant amount of nitrogen from rotation crops such as grass-legume pasture. With the use of higher amounts of chemical fertilizer and more effective weed control such rotations may not be of the same value as in the past.

OBJECTIVE: To determine the best system of management of the rice crop so that continued high yields can be economically obtained.

RESEARCH APPROACHES:

A. Develop crop management procedures that will minimize use of energy; for example, multiple application of materials and combined operational practices.

B. Determine the planting dates for maximum yield of existing and new varieties. Determine the value of planting at a date that will give maximum radiant energy to the crop.

C. Devise planting methods that will result in improved seedling survival and more vigorous early growth.

D. Compare continuous rice with rotations of rice and other crops to determine if benefits comparable to those which accrue from use of rotations can be obtained from the use of superior production practices, such as a high level of fertilization and effective weed control.

E. Determine the best varieties of rice for double cropping.

F. Develop methods to neutralize germination inhibitors in order to obtain better stands of rice.

G. Determine the effect of growth regulating chemicals on yield and growth habit of the crop.

H. Coordinate with research under RPA 209 and other aspects of 307.

POTENTIAL BENEFITS: Increase yields and improve efficiency of production.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.3		
No increase	1.0		
10% increase	1.1		
Recommended	-	1.8	1.8

Summary of Research Problem Area 308 - Mechanization of Production of Field Crops

Problem	Priority	SMY's				
		Current	No Increase	10% Increase	Recommended 1979	1984
A. Development of Improved Chemical Application Equipment	1	1.5	1.5	1.6	2.0	3.0
B. Energy Consideration in Rice Production	1	0.0	0.0	0.0	3.0	4.0
C. Development of Improved Harvest Equipment	2	0.2	0.2	0.2	1.0	1.0
D. Development of New Equipment for Rice Soil Tillage	3	0.4	0.4	0.5	1.0	1.0

DEVELOPMENT OF IMPROVED CHEMICAL APPLICATION EQUIPMENT

RPA 308-A

PRIORITY: 1

SITUATION: Use of chemicals in rice production has increased substantially in recent years and is expected to continue to increase in the foreseeable future. Most chemicals, including insecticides, herbicides, and fertilizers, are applied by use of airplanes. However, there is need for research on the development and use of ground equipment for application of chemicals prior to flooding and during the growing period, at which time the soil is covered with irrigation water. As pre-emergence chemicals are developed for rice there will be an expanded need to develop and evaluate application equipment.

OBJECTIVE: To develop more efficient and effective chemical application equipment for rice production.

RESEARCH APPROACHES:

A. Conduct studies to develop new techniques for applying chemicals to rice.

B. Develop new equipment for application of chemicals to rice.

C. Coordinate research with RPA's 209 and 307.

POTENTIAL BENEFITS: More uniform application of chemicals would result in savings through reduced application rates. New techniques and equipment for application may result in higher yields and lower application cost. An estimated 3% increase in yields could result from better application of all chemicals used in rice production.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.5		
No increase	1.5		
10% increase	1.6		
Recommended	-	2.0	3.0

ENERGY CONSIDERATION IN RICE PRODUCTION

RPA 308-B

PRIORITY: 1

SITUATION: Land preparation, water requirements, harvesting, processing, and handling make the rice industry a large consumer of energy in the form of hydrocarbon fuels. Traditionally, the rice industry has had to concern itself only to a very small extent in conserving energy. However, the entire cost-supply situation has changed drastically. No longer is an unlimited supply of fuel available at low cost. Fuel costs have risen by as much as 100% and supply is in doubt.

Present production systems are not as well coordinated as they could be to conserve fuel. Good weed and grass herbicides are available for use in rice. These used with minimum tillage and water could possibly result in production systems that would conserve energy.

There is not an exact understanding of minimum tillage in rice production. Research oriented toward developing a better concept of tillage requirements could result in energy savings.

OBJECTIVE: To develop rice production systems that utilize less energy than those commonly used.

RESEARCH APPROACHES:

A. Determine minimum tillage requirements for rice production.

B. Determine weed and grass control measures to be used with minimum tillage.

C. Determine implement and power unit requirements for minimum fuel usage.

D. Determine minimum water requirements for rice production.

E. Determine water sources for lowest fuel usage.

F. Study minimum inputs of materials and energy for maximum yields of particular varieties.

G. Coordinate research with RPA's 209, 307 and 309.

POTENTIAL BENEFITS: Development of rice production systems that require less fuel than those commonly employed could substantially reduce cost and result in energy conservation.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.0		
10% increase	0.0		
Recommended	-	3.0	4.0

DEVELOPMENT OF IMPROVED HARVEST EQUIPMENT

RPA 308-C

PRIORITY: 2

SITUATION: Rice is harvested in the United States by use of self-propelled combines. Lodging is quite common in rice and large quantities are lost due to shattering during the "pick up" of the lodged rice. Well-adjusted combines in good condition leave about 1% of the crop in the field, while poorly adjusted, usually older machines, lose more. One observer found as much as 14% of the crop left in the field and lost due to poor combine operation and adjustment. Additional losses occur during transfer to transport vehicles. Much of the riceland is poorly drained and presents problems of mobility for combines and transport vehicles.

Current methods of combining result in 2-4% shelled, mostly broken, rice which is conducive to insect damage, microbial attack, and an increase in free fatty acids.

There is a need to develop techniques for combine evaluation and adjustment, as well as development of equipment to more effectively recover lodged rice, and to minimize shelling and breakage in the field. There is also a need to develop improved field transport vehicles to reduce labor requirements and increase mobility.

OBJECTIVE: To develop new harvest and field transport techniques and equipment.

RESEARCH APPROACHES:

A. Develop standardized harvest techniques to improve efficiency of combine operations.

B. Develop improved pick-up equipment and more mobile combines.

C. Develop improved field transport equipment with better mobility requiring less labor.

D. Develop techniques and equipment that will result in more gentle handling of the rice.

E. Correlate with RPA 406.

POTENTIAL BENEFITS: Improved techniques and equipment for rice harvest would recover more rice with savings in labor during peak harvest periods. A savings of as much as 3% of the crop may be gained through improved harvest equipment.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.2		
No increase	0.2		
10% increase	0.2		
Recommended	-	1.0	1.0

DEVELOPMENT OF NEW EQUIPMENT FOR RICE SOIL TILLAGE

RPA 308-D

PRIORITY: 3

SITUATION: Practically all tillage equipment used in rice production and harvest was developed for crops other than rice. Rice production is unique in that large quantities of water are used in irrigation with resultant wet field conditions much of the year. Many land preparation and tillage operations are done in water or under wet conditions. Much of the tillage equipment now used in rice production was not designed to be operated under such severe conditions; consequently, depreciation is high and efficiency low.

Also of importance is the need to remove or otherwise dispose of crop residue. Traditionally, the straw has been burned or baled, then removed. Restrictions on burning due to pollution are becoming more severe, limiting this means of disposal.

There is a need to develop equipment, specifically for rice soil tillage, designed to operate in water and under wet conditions, and to incorporate into soil or otherwise dispose of crop residue.

OBJECTIVE: To develop equipment specifically for rice soil tillage.

RESEARCH APPROACHES:

A. Develop equipment for optimum tillage specifically for rice production.

B. Develop tillage techniques for land preparation in flooded soils.

C. Develop equipment for incorporating crop residue into soil.

D. Coordinate research with RPA 307.

POTENTIAL BENEFITS: Tillage equipment developed for rice production could reduce capital and depreciation cost, and improve field efficiency and yields. This could result in substantial annual input cost savings.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.4		
No increase	0.4		
10% increase	0.5		
Recommended	-	1.0	1.0

Summary of Research Problem Area 316 - Farm Business Management

Problem	Priority	SMY's Current	No Increase	10% Increase	Recommended 1979	Recommended 1984
A. Economics of Alternative Adjustment Opportunities on U.S. Rice Farms	1	1.0	1.0	1.1	1.5	2.0

ECONOMICS OF ALTERNATIVE ADJUSTMENT OPPORTUNITIES ON U.S. RICE FARMS

RPA 316-A

PRIORITY: 1

SITUATION: Agencies working with farm groups, as well as farm operators, are in constant need of information on cost, input requirements, and changing technology applicable to major farm enterprises. Two steps are involved in meeting this need; the first is securing and maintaining current information on all budget items, and the second is preparing systematic budgets which allow comparison of returns between enterprises.

OBJECTIVE: To obtain and organize economic information and procedural methods to be used for planning and managerial decisions for the purpose of maximizing farm incomes in major U.S. rice areas.

RESEARCH APPROACHES:

Basic enterprise data developed for rice and competing enterprises in earlier studies will be updated each second or third year. The revised budgets will be stored on computer tapes from which they can be retrieved as needed. Simplified enterprise budgets will be published as needed and distributed to agricultural agencies working with farmers. Through coordination between states, similar budgets will be developed for all rice-growing areas in the United States.

POTENTIAL BENEFITS: Such information is essential to decision making at the farm level as well as in development of policy and executing action programs at the national level.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.0		
No increase	1.0		
10% increase	1.1		
Recommended	-	1.5	2.0

Summary of Research Problem Area 405 - Production of Field Crops with Improved Acceptability

Problem	Priority	SMY's Current	No Increase	10% Increase	Recommended 1979	Recommended 1984
A. Developing Improved Varieties with Wider and Better Consumer Acceptance	2	2.4	2.4	2.6	5.0	6.0

DEVELOPING IMPROVED VARIETIES WITH WIDER AND BETTER CONSUMER ACCEPTANCE

RPA 405 -A

PRIORITY: 2

SITUATION: Although the United States produces less than 1% of the free world's rice, it is currently the number one exporter of rice. The annual U.S. per capita rice consumption approaches 8 pounds, with about 25% of this amount being in the form of specialty and convenience products. The consumption of these convenience-type products increases yearly. Improving consumer acceptability will increase the number of consumers and per capita consumption while not adversely affecting the number of heavy rice users. From a world-wide nutritional standpoint, high priority is attached to increasing the quantity and quality of protein in rice. Other nutritional qualities, whether increased for greater food value or decreased for dietary advantage, stimulate consumer acceptance. Flavor also affects consumer preference. There is a shortage of rice suited for specific industrial uses and major foreign markets. Varieties developed specifically for these markets would increase utilization and value of the crop. These quality characteristics are largely under genetic control and may be incorporated into new varieties through breeding techniques. Research by food processors and utilization laboratories must be closely coordinated with that of production scientists.

OBJECTIVES: To obtain information on current and long-range needs of the rice industry and incorporate the desired milling, cooking, processing, and nutritive qualities into new rice varieties to increase consumer acceptance, and to develop and/or implement reliable chemical, physical, and biological techniques to evaluate and monitor these characteristics.

RESEARCH APPROACHES:

A. Develop adapted varieties with higher levels of protein and lysine content of the grain in combination with other desired agronomic and quality characteristics. Carefully monitor potential new varieties for significant changes in nutrient content and quality of final consumer products.

B. Develop varieties with improved milling, cooking, processing, and nutritive characteristics. Develop and/or adapt reliable chemical, physical, and biological techniques to evaluate and monitor these characteristics.

C. Develop varieties resistant to smut and stink bugs and tolerant to environmental factors adversely affecting quality.

D. Develop varieties suited for specific industrial uses and major foreign markets.

E. Develop varieties with different grain sizes, shapes, aromas, flavors, and other organoleptic characteristics having broader consumer appeal.

F. Coordinate with research in RPA's 207, 208, 209, 307, 406, 407, 408, 501, 601, 604, and other aspects of 405.

POTENTIAL BENEFITS: The development of varieties with improved milling, cooking, processing, and nutritive qualities for domestic, foreign, and industrial consumer needs will materially benefit the ultimate consumer and cause a substantial increase in the value of the crop.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	2.4		
No increase	2.4		
10% increase	2.6		
Recommended	-	5.0	6.0

Summary of Research Problem Area 406 - New and Improved Food Field Crops

Problem	Priority	SMY's Current	No Increase	10% Increase	Recommended 1979	Recommended 1984
A. New Practical Procedures for Increasing Rice Milling Yields	1	2.9	2.9	3.2	4.0	4.0
B. Stabilization and Improvement of Brown Rice	2	0.0	0.0	0.0	1.0	1.0
C. Enriched Milled Rice Products	3	0.0	0.0	0.0	0.5	1.0
D. Development of New Processed Products	3	0.3	0.3	0.3	1.0	1.0
E. Induced Alterations in Processing Characteristics	4	1.4	1.4	1.5	1.5	1.5
F. New Food Uses for Rice Milling Fractions	4	0.0	0.0	0.0	0.5	0.5
G. New Uses for Rice Flour	5	0.0	0.0	0.0	0.5	0.5

NEW PRACTICAL PROCEDURES FOR INCREASING RICE MILLING YIELDS

RPA 406-A

PRIORITY: 1

SITUATION: Improvement of rice milling by increasing yields of head rice (whole kernels) and of total milled rice is of critical importance to the rice industry. The world's rice-consuming peoples prefer whole grains and will pay almost twice as much for them as for broken kernels. In direct contrast to most other cereal grains, rice is seldom consumed as flour, a potential market for broken rice.

Improvements in equipment and processing, such as sophisticated abrasive mills and solvent milling, have increased milling yields. However, pre-milling treatments to seal cracks, and the use of chemicals to soften the interface of the bran and endosperm and to harden the outer portion of the endosperm, could result in further improvements in economy and efficiency in bran removal without causing endosperm breakage. Closely related is the need for development of methods for increasing total milling yield by prevention of loss of white endosperm in polish, bran or hulls. Improvements in rice processing, from harvesting to final packaging for the consumer will increase total yields of milled rice and of whole-grain rice and should result in increased returns to the farmer and miller.

OBJECTIVE: To increase head and total rice yields during milling.

RESEARCH APPROACHES:

A. Develop methods for increasing head and total rice yields by chemical and/or physical pre-treatments of rough rice.

B. Investigate enzyme activity for softening bond between bran and endosperm.

C. Develop methods for removing less of the white outer layer of the endosperm during milling.

D. Develop equipment for milling and shelling indicated by A, B, and C in cooperation with industry.

E. Develop improved equipment for harvesting rice that results in less breakage and loss of rice in the field.

F. Coordinate with research of RPA's 307, 405, 408, 504, and 308.

POTENTIAL BENEFITS: Increase in milling yield of head and of total milled rice. Increased product value resulting from an increase in head rice yield of as much as 5% of rough rice plus an increase in total milling yield of as much as 3%.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	2.9		
No increase	2.9		
10% increase	3.2		
Recommended	-	4.0	4.0

STABILIZATION AND IMPROVEMENT OF BROWN RICE

RPA 406-B

PRIORITY: 2

SITUATION: Brown rice deteriorates quite rapidly in flavor and aroma on storage at ambient temperatures with an accompanying increase in free fatty acid content. Freshly dehulled brown rice has a pleasant nut-like flavor and is nutritionally superior to white milled rice. Stabilization of the initial flavor and aroma by development of a process using chemical or physical treatments, at a cost not to exceed the cost of milling plus the added value of the bran fraction, should yield a product of excellent market potential, domestically and especially for export. Brown rice has a dull off-white color as compared with the white milled product. The latter problem may be solved by decolorizing the bran or it may disappear as an objectionable characteristic with the development of a good brown rice product that is flavor and aroma stable for six months or more.

OBJECTIVE: To develop a storage-stable brown rice having good flavor, aroma, and appearance.

RESEARCH APPROACHES:

A. Stabilize brown rice flavor by development of coatings containing ingredients such as fats, fat derivatives, proteins, and antioxidants.

B. Develop chemical or physical treatments designed to inactivate lipases and lipoxidases to stabilize brown rice.

C. Develop chemical treatments to decolorize brown rice.

D. Develop a quicker and better method for cooking brown rice.

POTENTIAL BENEFITS: Introduction of a new highly nutritious product of acceptable flavor that will increase the domestic market for rice. The milling costs and breakage during milling will be reduced. Increases in the acceptability of brown rice and the proportion of the kernel used as food should be achieved.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.0		
10% increase	0.0		
Recommended	-	1.0	1.0

ENRICHED MILLED RICE PRODUCTS

RPA 406-C

PRIORITY: 3

SITUATION: Enriched rice is generally fortified with thiamine, niacin, iron, calcium, and vitamin D. At present rice is enriched by one of two methods. In one method, 0.5 lb. of milled rice is heavily fortified and coated with water insoluble films and then blended with 99.5 lbs. of milled rice. This method is not fully acceptable because of visible differences between enriched kernels and non-enriched kernels. In another method of enrichment the vitamin-mineral supplement is added as a powder to the milled rice. The objection to this method is that the enrichment mix may be lost if the rice is either washed before cooking or is cooked in an excess of water. In neither present method of enriching rice is riboflavin included. It would be advantageous to enrich milled rice and processed rice products with other vitamins, protein, and selected essential amino acids such as lysine and threonine. A uniformly enriched product, stable to washing and providing supplementary nutrients, is needed.

OBJECTIVE: To develop improved enriched rice or enriched rice products.

RESEARCH APPROACHES:

A. Enrich rice by treatment of the kernels to allow impregnation of nutrients.

B. Enrich rice by encapsulation or mordanting nutrients onto the grain surface.

C. Enrich rice by processing rice or rice flour and incorporating nutrients prior to reconstituting into a new-formed rice product.

D. Investigate methods of incorporating riboflavin without imparting a yellow color to the cooked rice.

E. Enrich rice with protein and/or essential amino acids.

F. Coordinate with research of RPA's 307 and 405.

POTENTIAL BENEFITS: New outlets for rice where nutritional value is recognized or essential, due to superior formulation and product acceptability.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.0		
10% increase	0.0		
Recommended	-	0.5	1.0

DEVELOPMENT OF NEW PROCESSED PRODUCTS

RPA 406-D

PRIORITY: 3

SITUATION: Per capita consumption of rice in the U.S. has increased about 25% (1.5 lb.) in the past 10 years. Most of the increase has been in processed convenience-type products, of which a major one is quick-cooking (precooked) rice. Inefficient cooking, washing, and drying processes cause large losses of flavorful soluble solids and much breakage, with resulting high costs. Reduction of total product costs and losses may be possible by application of process innovations from other industries. There is also a potential for increasing the variety and reducing costs of the few frozen rice foods now marketed. Additionally, there is an unexplored possibility for making rice foods with characteristic properties and flavors by malting and fermentation processes.

OBJECTIVE: To expand consumption of rice foods by developing new processes and an increased variety of improved, uniformly high-quality, lower cost rice products.

RESEARCH APPROACHES:

A. Investigate process innovations for diminishing losses of solids and flavor and reducing costs in making quick-cooking rice.

B. Determine relations of composition and surface properties of over-milled medium-grain rices to suitability for preparing quick-cooking rices.

C. Devise cost-reducing processes for developing a variety of frozen rice foods.

D. Study potentials of developing rice foods based on malting or fermentation processes.

E. Cooperate with industry in A, B, C, and D, and in evaluating procedures developed in this research.

F. Coordinate with research of RPA's 307 and 405.

POTENTIAL BENEFITS: Continued expansion of rice markets would result from the availability of convenience type processed rice foods at reduced cost and with improvement in variety and quality of products offered.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.3		
No increase	0.3		
10% increase	0.3		
Recommended	-	1.0	1.0

INDUCED ALTERATIONS IN PROCESSING CHARACTERISTICS

RPA 406-E

PRIORITY: 4

SITUATION: Rices grown in the U.S. and abroad vary widely in their cooking and processing characteristics. Consumer preference usually follows the characteristics of the locally grown varieties. There is a need for the development of a practical process for altering the plasticity to improve cooking characteristics of rice. Alteration of rices by processing of even a fraction of the total production to resemble more desirable types would assist in broadening the rice market. There is ample evidence in recent research reports that rice cooking characteristics are altered during storage at ambient temperatures and that similar changes can be induced by mild steam treatments. More drastic changes are commonly induced by parboiling. A system of processing designed to modify all varieties is needed to satisfy diverse market requirements. Improved instant rice, for example, would increase the use of rice.

OBJECTIVE: To devise methods for treating rice to alter its cooking and processing characteristics to improve acceptability by specific consumers.

RESEARCH APPROACHES:

A. Investigate heat or heat-chemical treatments of rice to accelerate changes normally associated with aging.

B. Develop a processing system for changing the plasticity of rice to alter its cooking characteristics by combinations of heat-pressure-moisture and/or chemical treatments.

C. Identify the rice constituent(s) affected when processing change occurs and identify why different rices react differently during cooking.

D. Develop better way of assessing cooking quality.

E. Coordinate with research of RPA's 307 and 405.

POTENTIAL BENEFITS: Expansion of the domestic and foreign utilization of domestic rice by supplying more acceptable and uniform products to specific markets.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.4		
No increase	1.4		
10% increase	1.5		
Recommended	-	1.5	1.5

NEW FOOD USES FOR RICE MILLING FRACTIONS

RPA 406-F

PRIORITY: 4

SITUATION: Rice bran and polish, comprising about 10-11% by weight of rough rice, have high nutritional value as is shown by their amino acid analyses. They are extensively used in livestock and poultry feed. A comparatively small proportion of high-quality polish is now used in baby foods. Bran, usually including some hull fragments, contains too much fiber for general food use. Improvement or modification of the properties of these potentially nutritious protein sources or their use in development of protein concentrates, would aid in meeting low-cost protein needs not only in the United States but throughout the world. Needed are improvement in stability and minimization of microorganism and fiber contents.

OBJECTIVE: To develop suitable food uses for rice polish and other fractions obtained from rice bran to provide added sources of low-cost, nutritious protein foods.

RESEARCH APPROACHES:

A. Devise procedures for improving the stability and minimizing the microbial breakdown of rice polish.

B. Investigate methods for preparing high-protein, low-fiber products from rice bran.

C. Utilize the compositional and functional properties of these upgraded milling fractions, both as entities and as combinations with other ingredients, in providing esthetic and nutritional foods.

D. Cooperate with industry in A, B, and C, and in evaluating procedures developed in this research.

E. Coordinate with other research of RPA 406.

POTENTIAL BENEFITS: Rice bran and polish offer potential sources of modestly priced high-quality protein for human consumption. By utilizing this protein directly, instead of passing it through the animal protein cycle, large additional amounts of low-cost nutritious protein foods could be made available for meeting the urgent world needs.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.0		
10% increase	0.0		
Recommended	-	0.5	0.5

NEW USES FOR RICE FLOUR

RPA 406-G

PRIORITY: 5

SITUATION: Because rice is traditionally eaten as whole grains, its potential uses in flour form have been inadequately explored. Some flour is produced from broken kernels and used in baby food, prepared mixes, and as an additive to other cereals for breakfast foods. Flour from waxy rice, a very minor crop, has special uses in frozen sauces and gravies. The bland flavor of these rice flours does not detract from flavors of other foods in mixtures, but allows a wide potential for added flavorings.

OBJECTIVE: To develop new uses for rice flours in formulated food products.

RESEARCH APPROACHES:

A. Develop a method of preparing rice flour from the chits in rice bran.

B. Develop rice flour gruels, custards, puddings, and other soft foods for use by young children, convalescents, elderly persons, and those with allergies to other cereals, eggs, and milk.

C. Examine the potential for rice flours as ingredients in or bases for baked goods and pasta products.

D. Coordinate with other research of RPA 406.

POTENTIAL BENEFITS: Increasing the value of small broken pieces by expanded uses as flour would decrease milling costs placed on whole-grain rice.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.0		
10% increase	0.0		
Recommended	-	0.5	0.5

Summary of Research Problem Area 407 - New and Improved Non-Food Field Crops

Problem	Priority	SMY's Current	No Increase	10% Increase	Recommended 1979	Recommended 1984
A. Utilization of Rice Hulls	1	0.0	0.0	0.0	2.0	2.0
B. Feed Uses for Rice Milling Fractions and Straw	2	0.8	0.8	0.9	5.0	5.0

UTILIZATION OF RICE HULLS

RPA 407-A

PRIORITY: 1

SITUATION: Disposal of rice hulls is a major problem of the rice milling industry. About 20 million cwt (100 lbs.) of rice hulls are produced per year as a by-product of rice milling. At present some of the hulls find useful outlets as cattle roughage, poultry litter, and for other purposes. There is a need to develop additional uses for hulls, such as chemicals, and to expand markets.

OBJECTIVE: To develop new products from rice hulls.

RESEARCH APPROACHES:

A. Investigate the chemical composition of rice hulls of present commercial varieties as a guide for development of uses for rice hulls.

B. Investigate methods of burning rice hulls, without creation of smoke pollution, and development of power from the heat energy released.

C. Investigate the use of rice hulls in wallboard and other molded objects and the production of useful chemicals such as $SiCl_4$, SiC, silica gel, etc.

D. Develop methods for efficient carbonization of rice hulls to recover useful organic by-products and carbonaceous residues suitable for briquetting.

E. Coordinate with research of RPA 901 and other aspects of 407.

POTENTIAL BENEFITS: Present air and land pollutants from rice hull disposal will be removed by development of profitable products which will provide new industrial opportunities in rural areas and lower cost products for consumers.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.0		
10% increase	0.0		
Recommended	-	2.0	2.0

FEED USES FOR RICE MILLING FRACTIONS AND STRAW

RPA 407-B

PRIORITY: 2

SITUATION: New air and land pollution regulations threaten to disrupt procedures traditionally used to dispose of residues left after growing and milling rice. The logical outlet for these residues is in animal feeds. Feeds provide the nutrients for the production, maintenance, and growth of animals but in certain feedstuffs the nutrients are not utilized biologically to their maximum extent. This is particularly true of high fiber feeds and rice bran, hulls, and straw fall in this category. As a result the available energy in these materials is too low to allow their extensive use in poultry or ruminant rations.

Processing offers ways to increase the biological availability of nutrients in feeds. For example, research has shown that metabolizable energy (ME) can be increased significantly by processing--31% in the case of steam-pelleted wheat bran, and up to 100% in steam-pelleted alfalfa. Ammoniating rice hulls at high temperature produces a useful protein supplement for ruminants. High-pressure steam treatment of alfalfa stems and wood pulp has resulted in noticeably increased digestibility in artificial rumen trials. The present need is to find ways to treat rice by-products to increase both their energy and digestibility so they can serve more widely in meeting the growing needs of our animal-based industries.

OBJECTIVE: To develop processing treatments for rice milling fractions and straw that will increase the utilization of their energy and nutrients by ruminants or monogastric animals.

RESEARCH APPROACHES:

A. Use chemical analyses to make preliminary estimates of nutritive value of crop and processing residues.

B. Investigate use of physical processes such as grinding, milling, and pelleting to enhance the nutrient qualities of rice milling fractions and straw.

C. Investigate process treatments involving use of chemicals, enzymes, heat, and/or pressure to increase nutrient availability in these materials.

D. Use *in vitro* digestibility techniques and digestion and metabolism trials with animals to determine nutritive value.

POTENTIAL BENEFITS: Increased utilization of hulls and straw will provide economic usage of these products.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.8		
No increase	0.8		
10% increase	0.9		
Recommended	-	5.0	5.0

Summary of Research Problem Area 408 - Marketing Quality of Field Crops

Problem	Priority	SMY's Current	No Increase	10% Increase	Recommended 1979	Recommended 1984
A. Improving Techniques for Detection and Control of Insects in Stored Rice	1	1.3	1.3	1.4	3.0	3.0
B. Improved Methods of Rice Drying	2	0.7	0.7	0.8	1.5	1.5
C. Determination of Physical Parameters of Rice	2	0.4	0.4	0.4	1.0	1.0
D. Storage of Brown Rice	2	0.0	0.0	0.0	1.0	1.0
E. Improved Methods of Rice Storage	3	1.0	1.0	1.1	1.5	2.0
F. Maintaining Quality of Rough Rice by Detection and Prevention of Post-Harvest Deterioration by Fungi and Other Microorganisms	3	0.0	0.0	0.0	2.0	2.0
G. Drying and Milling Characteristics Related to the Physical and Mechanical Properties of the Rice Grain	3	0.1	0.1	0.1	0.5	0.5

IMPROVING TECHNIQUES FOR DETECTION AND CONTROL OF INSECTS IN STORED RICE

RPA 408-A

PRIORITY: 1

SITUATION: A substantial amount of stored and exported rice is either lost or damaged to the extent that reduction in value results due to stored grain insects. At present, there is a need for methods to determine the existence of insects in large bulk storage units in order to take protective measures before loss occurs. Insecticides used to control insects of stored rice may result in chemical residues that warrant concern. There is a continuing need to develop insecticides and methods of application that leave little or no chemical residues in order to protect rice as a human food.

OBJECTIVES: To develop optimum detection and control measures for insects attacking rice and rice products, and to develop effective insecticide application methods and fumigation techniques and biological or cultural control methods that will result in the lowest possible chemical residues.

RESEARCH APPROACHES:

A. Acquire basic information on population dynamics, behavior, migration habits, life cycle, life history, genetics, and other biological activities which can be used to conduct suppression, eradication, or control studies against these pests.

B. Determine the effect of major storage insect pests on rough, brown, and milled rice and determine the economic injury threshold for each species.

C. Conduct studies to develop instruments and techniques for rapid, objective measurement of internal "hidden" insect infestation of rice.

D. Screen rice varieties to find germplasm resistant to insects of stored rice. Identify the nature of resistance and manner of inheritance. Determine the feasibility of developing varieties that are resistant to more than one insect species.

E. Conduct studies on fumigation, protectants, environmental control, and other methods of inhibiting the spread of stored grain insects in rough and milled rice, with emphasis on methods leaving little or no chemical residue.

F. Develop techniques to combine these various approaches in such a manner that destructive insect populations can be monitored and controlled only when necessary.

G. Coordinate with other research in RPA 408.

POTENTIAL BENEFITS: Reduce both quantity and quality losses from stored grain insects and insure greater value to the producer, processor, and marketer. Eliminate chances of residue in rice and by-products, making them safer for consumer use.

Improve the image of the United States as an exporter by delivery of clean, insect-free, and undamaged rice, to assure a fair share in the foreign market.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.3		
No increase	1.3		
10% increase	1.4		
Recommended	-	3.0	3.0

IMPROVED METHODS OF RICE DRYING

RPA 408-B

PRIORITY: 2

SITUATION: Rough rice is harvested by combines at a high moisture content and requires drying to 13% moisture content or lower for safe storage and optimum milling. The predominance of early-maturing varieties in the southern rice-producing area has resulted in a shorter harvesting season than prevailed previously. Drying facilities are in short supply during the peak of the harvesting season, but capital outlay to build additional drying capacity is hard to justify for facilities that are used no more than 30 to 45 days a year. This has caused rice to remain unharvested longer than desirable and resulted in loss of quantity and quality after harvesting.

The energy crisis threatens a shortage of fuel for crop drying, even though consumption of natural or L.P. gas accounts for a small percentage of drying costs.

There is a need for research to develop better drying methods and equipment to effectively improve the handling capacity of commercial dryers. Additional research is needed to develop drying methods using sources of energy other than fossil fuels.

OBJECTIVES: To determine optimum conditions and develop drying methods and equipment that will dry rice faster while maintaining or improving its quality and to develop drying methods that require less energy input from fossil fuels.

RESEARCH APPROACHES:

A. Determine more exactly the factors and describe mathematically the parameters affecting drying, such as the moisture gradient through the grain and its effect on rice breakage.

B. Develop techniques and equipment to dry rice more quickly and improve the capacity of drying facilities while maintaining or improving the quality during drying.

C. Develop efficient techniques and equipment for rice drying to utilize energy other than that provided by fossil fuels.

D. Coordinate research with RPA 406.

POTENTIAL BENEFITS: Improve profits of commercial drying facilities, reduce drying costs to producers and cost of food to consumers. Improve quality and quantity of rice after harvesting. Conserve fossil fuel,

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.7		
No increase	0.7		
10% increase	0.8		
Recommended	-	1.5	1.5

DETERMINATION OF PHYSICAL PARAMETERS OF RICE

RPA 408-C

PRIORITY: 2

SITUATION: As processing, drying, storage, and handling of rice become more exact and sophisticated, a growing need arises to know precise properties of the grain. Such information is essential for accurate analysis, design, and operation of systems for rice harvesting, handling, processing, and storage of rough, brown, and milled rice.

OBJECTIVE: To determine and evaluate physical parameters necessary to develop better processing and handling techniques and systems.

RESEARCH APPROACHES:

A. Determination of engineering properties as related to temperature and moisture content to include specific heat, thermal conductivity, thermal diffusivity, individual grain density, grain hardness, grain volume, grain surface area, hygroscopic equilibria, angle of repose, coefficient of friction, permeability, bulk density, and water absorption.

B. Studies of the physics of the rice grain to relate stress, strain, tissuring, etc., to mechanical forces, moisture, and/or temperature gradients as they may occur in the handling, drying, and other processes.

C. Studies to develop instruments and/or techniques for rapid measurement of quality parameters in rough and milled rice.

D. Coordinate research efforts with RPA's 208, 307, 406, and 501.

POTENTIAL BENEFITS: More exact knowledge of the physical parameters of rice will enable the engineer and/or process scientist to design better and more efficient handling and processing components and systems for rice.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.4		
No increase	0.4		
10% increase	0.4		
Recommended	-	1.0	1.0

STORAGE OF BROWN RICE

RPA 408-D

PRIORITY: 2

SITUATION: Rice is mainly stored in the rough form. Storage of brown, rather than rough rice, could result in savings of about 20% by weight and 35% by volume in the storage structures.

Much brown rice is transported to export markets as brown rice. There has been some reported deterioration of the brown rice in storage during transport. Information is needed to determine optimum environmental conditions of storage for brown rice.

OBJECTIVES: To determine optimum environmental conditions of temperature, air flow rates, and moisture content affecting storage of brown rice. To develop optimum systems of storage to reduce storage losses and reduce the cost.

RESEARCH APPROACHES:

A. Determine environmental conditions affecting storage quality.

B. Determine processing conditions which affect storage quality of brown rice.

C. Investigate pre-storage treatments which may help maintain quality of brown rice in storage.

POTENTIAL BENEFITS: Improved storage could result in the ability to more effectively store, transport, and market brown rice. Adequate techniques of brown rice storage could save as much as 20% by weight and 35% by volume in storage structures.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.0		
10% increase	0.0		
Recommended	-	1.0	1.0

IMPROVED METHODS OF RICE STORAGE

RPA 408-E

PRIORITY: 3

SITUATION: Technology of rough rice storage is comprehensive; however, the threatened energy shortage might nullify aeration and other techniques useful for maintaining quality in storage. Technology of brown and milled rice in bulk storage is less comprehensive, but storage of brown, rather than rough, rice could result in a 35% increase in bin space utilization.

Research is needed to determine optimum moisture content of rough rice to be stored without aeration and to determine efficient operating procedures for rough rice stored at a high moisture content as a means of reducing energy for drying. Research to develop technology for bulk storage of brown and milled rice is needed.

OBJECTIVES: To determine optimum environmental conditions for storage of rough, brown, and milled rice and to develop efficient operating procedures of aeration systems or other mechanisms for obtaining these environmental conditions.

RESEARCH APPROACHES:

A. Determine temperatures, moisture contents, and time periods at which rough rice may be stored without aeration.

B. Determine relative energy efficiency of drying rough rice to a moisture content where it may be safely stored without aeration or maintain quality in storage of higher moisture content rice by use of aeration.

C. Develop equipment and techniques and design lower cost structures for bulk storage of brown and milled rice.

D. Coordinate with other research in RPA 408.

POTENTIAL BENEFITS: Improved storage of rough rice could result in reducing drying costs and energy input by reducing the amount of drying.

Storage of brown rice will reduce the volume of bin space required for rough rice and make storage structures less costly. Handling milled rice in bulk, rather than in bags, could save labor at mills and transportation facilities.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.0		
No increase	1.0		
10% increase	1.1		
Recommended	-	1.5	2.0

MAINTAINING QUALITY OF ROUGH RICE BY DETECTION AND PREVENTION OF POST-HARVEST DETERIORATION BY FUNGI AND OTHER MICROORGANISMS

RPA 408-F

PRIORITY: 3

SITUATION: Rice is harvested at moisture contents of 18 to 24%; thus it must be conditioned promptly to moisture levels consistent with safety in storage to prevent the rapid development of microbiological deterioration. Fungi of the genera Aspergillus and Penicillium are most often associated with post-harvest deterioration of rough rice. Other fungi and/or bacteria may at times also be involved. Fungal activity often causes discoloration of kernels called "damage" and "heat damage". This discoloration is intensified in the parboiling process and causes so-called "peck" or "pecky kernels" that must be removed by expensive sorting devices. Kernel structure is weakened by fungal activity, resulting in lower milling yields. Substances affecting taste and nutritional value may be introduced by the activity of microorganisms. Present drying and storage methods must be continually examined and updated to best maintain new varieties during drying storage. New production techniques often introduce additional problems in regard to drying and storage that must be examined to relate their effect on the prevention of microbiological deterioration.

OBJECTIVE: Maintain market quality of rough rice through development of improved methods of drying, conditioning, and storage.

RESEARCH APPROACHES:

A. Determine the relationship to new varieties among variables of handling, conditioning, and storage.

B. Search for effective ways to reduce deterioration and losses caused by fungi and other microorganisms.

C. Develop methods for the detection of undesirable by-products of the growth of microorganisms in rough rice.

D. Delineate the relation between temperature and humidity and varietal reaction as they affect the microbiological development.

E. Examine the practicability of chemical treatment or controlled atmosphere for short-term storage of high moisture rice.

F. Coordinate with research in RPA's 503 and 702.

POTENTIAL BENEFITS: Reduce economic losses to the rice industry by maintaining market grade and quality and preventing loss in quantity during post-harvest conditioning, handling, and storage. Maintain the high nutritional value of rice and insure the availability of an attractive and wholesome product to the ultimate consumer.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.0		
10% increase	0.0		
Recommended	-	2.0	2.0

DRYING AND MILLING CHARACTERISTICS RELATED TO THE PHYSICAL AND MECHANICAL PROPERTIES OF THE RICE GRAIN

RPA 408-G

PRIORITY: 3

SITUATION: The drying and milling characteristics of new rice selections are usually not known until after a variety has been released. Such information would be helpful to rice breeders early in the breeding program. It might have an effect on some selections. Several of the physical parameters of different varieties of rice have been determined. Others are being studied. Research is needed to relate the drying and milling characteristics to some physical and mechanical properties of the grain.

OBJECTIVE: To determine the physical and mechanical properties of the rice grain which affect drying, shelling, and bran removal and to relate these to drying and milling characteristics.

RESEARCH APPROACHES:

A. Determine the physical and mechanical properties of the rice grain which affect drying, shelling, and bran removal.

B. Develop "standard" drying curves for present varieties.

C. Develop a "shelling index" technique and equipment to relate and compare different rice varieties and selections as to the energy required to remove the hull.

D. Develop a bran removal index technique and equipment to relate and compare different rice varieties and selections as to the energy required to remove the bran.

E. Coordinate with RPA 406 and other aspects of 408.

POTENTIAL BENEFITS: Aid rice breeders in the selection process to compare the drying and milling characteristics.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.1		
No increase	0.1		
10% increase	0.1		
Recommended	-	0.5	0.5

Summary of Research Problem Area 501 - Improvement of Grades and Standards

Problem	Priority	SMY's Current	No Increase	10% Increase	Recommended 1979	1984
A. Identification and Evaluation of Quality Variables in Rice	2	0.3	0.3	0.3	1.0	1.0
B. Development of Techniques and Equipment for Commercial Measurement of Quality Variables in Rice	2	2.5	2.5	2.8	4.0	5.0

IDENTIFICATION AND EVALUATION OF QUALITY VARIABLES IN RICE

RPA 501-A

PRIORITY: 2

SITUATION: Grades and standards in the marketing system should provide meaningful communication with respect to quality of a product in relation to its price and intended use. A system of grades and standards recognizing meaningful quality factors should be developed and established.

OBJECTIVE: To provide grades and standards that will effectively communicate value differences for varying gradations of quality.

RESEARCH APPROACHES:

A. Evaluate the effectiveness of existing grades and standards in serving the needs of sellers and buyers and for reflecting different gradations of quality which affect value and use.

B. Develop descriptive terminology for grades and standards which will characterize the different attributes of rice and rice products so as to facilitate communication between buyers and sellers.

C. Develop a uniform system of grades and standards recognizing those characteristics which reflect value and affect use.

D. Coordinate with research under RPA's 405, 406, 408, 504, and other aspects of 501.

POTENTIAL BENEFITS: Improved communication through more precise terminology for describing varying gradations of quality. Prices would more accurately reflect value and a more competitive position in marketing rice in the world market would result.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.3		
No increase	0.3		
10% increase	0.3		
Recommended	-	1.0	1.0

DEVELOPMENT OF TECHNIQUES AND EQUIPMENT FOR COMMERCIAL MEASUREMENT OF QUALITY VARIABLES IN RICE

RPA 501-B

PRIORITY: 2

SITUATION: Rapid, objective, and accurate methods or devices are needed for the measurement of quality characteristics of economic significance. Many of the quality factors such as degree of milling, color, and broken content are now determined subjectively. There is a relatively high chance of error due to human judgment. The laboratory mill presently used to measure milling yield is not indicative of the commercial milling because U.S. mills are now using more efficient Japanese made milling equipment. Little or no mechanical sampling equipment is in use in the rice industry. Sampling is largely performed by hand with little assurance that sampling is statistically sound.

OBJECTIVE: To develop techniques and equipment for measurement of the commercial value of rice.

RESEARCH APPROACHES:

A. Develop techniques and equipment for rapid, objective, and accurate measurement of quality in commercial and marketing channels including degree of milling, milling yield, broken content, processing properties, and other factors used in routine grading.

B. Develop mechanical sampling devices.

C. Coordinate with research under RPA's 405, 406, 408, and other aspects of 501.

POTENTIAL BENEFITS: Development of instruments or machines and techniques for rapid, objective sampling and measurement of quality would lead to a reduction in the cost of inspection and grading. In addition, laboratory results would provide more accurate estimates of commercial results if better laboratory equipment were developed.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	2.5		
No increase	2.5		
10% increase	2.8		
Recommended	-	4.0	5.0

Summary of Research Problem Area 503 - Efficiency in Marketing Agricultural Products and Production Inputs

Problem	Priority	SMY'S				
		Current	No Increase	10% Increase	Recommended 1979	Recommended 1984
A. Economics of Conditioning, Storage, Milling, Transporting, and Marketing of Rice	1	0.4	0.4	0.4	1.5	2.0

ECONOMICS OF CONDITIONING, STORAGE, MILLING, TRANSPORTING AND MARKETING OF RICE

RPA 503 -A

PRIORITY: 1

SITUATION: Current methods of collecting, drying, storing, milling and transporting rice have evolved over the years, and reflect the adaptation of changes in technology as they emerged. The impact of larger volumes of production in the years ahead will force additional changes, particularly in capital investment to rehabitate old or install completely new facilities. Recent developments in financing and integrated management have moved production, processing and marketing toward a continuous activity, frequently shared by the same ownership and managerial group. Thus integrated management systems continue to reflect higher degrees of specialization, and to account for larger percentages of total production.

OBJECTIVE: To identify and forecast the impact of internal system changes on such factors as (1) supply and demand; (2) modes of transportation and associated costs; and (3) government policy and programs that are related to production, drying, milling, storing, and shipping of rice.

RESEARCH APPROACHES:

A. Collect information from representative firms on employment, equipment, facilities, wage rates, and overhead items.

B. Develop cost schedules for handling, storing, and processing under present arrangements to show the effects of such factors as size of plant, level of use (related to capacity), seasonality of demand, and location advantages on cost per unit of output.

C. Develop least-cost models for conditioning, processing, storing, and shipping of rice under closely integrated systems.

D. Evaluate the economic implications of policy alternatives separately and in various combinations to appraise their effects on the total system.

POTENTIAL BENEFITS: Information developed will be helpful to management within each segment of the industry in minimizing cost at each stage of production, processing, transporting, and marketing. Minimizing costs is an essential ingredient to internal efficiency, and therefore is essential in maintaining a strong competitive position in world markets.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.4		
No increase	0.4		
10% increase	0.4		
Recommended		1.5	2.0

Summary of Research Problem Area 506 - Supply, Demand, and Price Analysis

Problem	Priority	SMY's				
		Current	No Increase	10% Increase	Recommended 1979	Recommended 1984
A. Current Outlook and Situation Analysis for Rice	1	0.3	0.3	0.3	0.5	0.5
B. A Price Analysis of the Rough Rice Market in the Gulf Area of the United States	1	1.0	1.0	1.1	1.5	1.5

CURRENT OUTLOOK AND SITUATION ANALYSIS FOR RICE

RPA 506-A

PRIORITY: 1

SITUATION: Farmers and the agribusiness community make operating decisions at varying times during the year, and are in need of information on plantings, crop progress, sales, market trends, and related factors. Both short- and long-term decisions are influenced by information on the U.S. rice industry, as well as information on major world rice centers. Although this is a current information gathering activity, the results are used in making long-term decisions affecting the U.S. rice industry and related policies.

OBJECTIVE: Appraise the current and prospective economic positions of rice and other food grains.

RESEARCH APPROACHES:

Regularly assemble, compile, and analyze data from many sources on production, stocks, total supplies, domestic utilization, foreign trade, prices, and government support operations for rice. Situation reports will be released in March and October each year.

POTENTIAL BENEFITS: Provide information on latest development in the rice industry for use of farmers, agribusiness interests, policy formulators, and program administrators.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.3		
No increase	0.3		
10% increase	0.3		
Recommended	-	0.5	0.5

A PRICE ANALYSIS OF THE ROUGH RICE MARKET IN THE GULF AREA OF THE UNITED STATES

RPA 506-B

PRIORITY: 1

SITUATION: Quality determination and the pricing system for rough rice have never been very satisfactory in the United States. In the Gulf Coast area particularly, where about half of the domestic crop is produced, neither the farmers nor buyers will accept grade designations with a standard scale of discounts as a basis for price determination. Instead, the industry still relies on the awkward and expensive system of selling by auction. In other grains where quality determinations and a standard scale of discounts are readily accepted, growers immediately and clearly know how much they lose for damage, foreign material, and other specific factors. Contrasted to rice growers they can make informed decisions on what practices should be changed to obtain greatest net returns. Trading by auction rather than by standards also inhibits the development of organized futures markets and of further coordination in the industry. Futures markets often result in efficient price communications and in viable price insurance for growers, processors, warehousemen, financial institutions and others. Further coordination of the industry could increase physical marketing efficiency.

OBJECTIVES: To develop and test an analytical procedure for measuring price performance in the Gulf Area rice market through these steps: (1) using contemporary price theory, develop a model for the market that is consistent with real world observation; (2) develop a set of *a priori* predictions of measured price relations expected in this market; (3) measure predicted price relations in a sample of *ex post* market prices; and (4) evaluate market price performance in the context of the *a priori* price predictions.

RESEARCH APPROACHES:

A. Examine sales records provided by the growers associations for price of lots, and for factors which comprise the time, space, and form components of the price of rough rice.

B. Market participants (producers, driers, sales operators, and mills) will be classified on the basis of size of operation in order to determine the effect of these elements on prices.

C. Econometric procedures will be used to determine the effect of selected variables on prices in the rough rice market.

POTENTIAL BENEFITS: Growers, buyers, and the agribusiness community will become better informed on the importance of various quality factors on prices. Consequently, greater emphasis can be given to upgrading the quality of rough rice, thus improving efficiency at all levels.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	1.0		
No increase	1.0		
10% increase	1.1		
Recommended	-	1.5	1.5

Summary of Research Problem Area 601 - Foreign Market Development

Problem	Priority	SMY's Current	No Increase	10% Increase	Recommended 1979	Recommended 1984
A. Effect of World Rice Supply, Demand, and Trade on Policy Alternatives and the U.S. Rice Industry	1	3.4	3.4	3.7	5.0	5.0
B. Expansion of Foreign Markets for United States Rice	1	0.4	0.4	0.4	1.5	2.0

EFFECTS OF WORLD RICE SUPPLY, DEMAND AND TRADE ON POLICY ALTERNATIVES AND THE U.S. RICE INDUSTRY

RPA 601-A

PRIORITY: 1

SITUATION: The U.S. rice industry depends heavily on export outlets which are of two general types. One consists of dollar sales to the commercial markets of the Western Hemisphere, Western Europe, the Middle East and South Africa. The other consists of exports under the Public Law 480 Program. Factors determining the volume of exports to the two types of markets are quite different and must be understood if a sound marketing program is developed. There is urgent need for information pertaining to market developments and changing trends that will influence world trade flows. The adoption of recently developed high-yielding varieties and related production technology is a part of these adjustments. At least two probable effects could occur under normal conditions: (1) a decreasing dependence by importing countries on the U.S. as a supplier of rice, and (2) increased competition from surplus countries in a number of world markets. Evaluation of world supply-demand changes and the implications to the U.S. rice industry also requires current information on technological changes in the domestic rice industry and of the implications of such changes on supply response, producers' incomes, and government policy alternatives. Estimates of the impact of each policy alternative on consumer demand and costs are necessary to reach a final evaluation.

OBJECTIVES: To determine the effects of emerging technological and structural developments on the income potentials of representative rice farms, and on the rice supply response in major U.S. rice areas; (2) to project rice production and export supplies in the major world rice-producing countries and regions; (3) to project demand relationships for rice in the U.S. and world markets, and determine the likely effects of projected world supply-demand interrelationships on world trade; and (4) to appraise the implications of projected domestic and world supply-demand interrelationships to (1) U.S. government policy; (2) the competitive position of U.S. rice producers, and (3) the rice agribusiness industries.

RESEARCH APPROACHES:

A. Changes in practices, input requirements and associated costs and levels of production resulting from technological change will be determined periodically from rice farmers, consultation with research and extension personnel, leaders in the rice industry, and secondary sources.

B. Projections of production and export potentials for each of the major rice-producing countries will be made to 1980 and 1985. The potential impact of high-yielding varieties compared with traditional varieties will be taken into account.

C. The total demand for U.S. rice will be based on (1) the total food and industrial uses within the U.S., (2) the commercial demand of developed countries, and (3) the deficit food needs of developing countries which usually are met by unilateral government contracts, including concessional sales and grants from the U.S. Estimates of the demand for the competitive markets of developed countries will be based on traditional demand theory, with adjustments for the effects of government intervention. Estimates of the residual markets of developing countries will be based on projected needs minus production. Projections of total needs in the residual supplied markets will be derived from historical trends in consumption as affected by population, government policy, changes in tastes and preferences, supply, etc. Demand estimates for the U.S. domestic market will largely entail updating previous work so that it is adaptable to the over-all analysis.

D. An "International Rice Model" will be adapted as a vehicle to relate the interaction of the demand-supply relationships referred to in B and C above. The proposed project will involve a team effort between the University of Arkansas, Texas A & M University, and the Economic Research Service.

POTENTIAL BENEFITS: The competitive rice situation in world markets will be determined and permit allowances for necessary adjustments.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	3.4		
No increase	3.4		
10% increase	3.7		
Recommended	-	5.0	5.0

EXPANSION OF FOREIGN MARKETS FOR UNITED STATES RICE

RPA 601-B

PRIORITY: 1

SITUATION: Two-thirds of the rice grown in the U.S. is exported. Consequently, it is imperative that greater emphasis be placed on expanding demand for rice in traditional as well as any yet undeveloped markets in foreign countries. Demand for U.S. rice is affected by the quality and selling price in foreign markets compared with available supplies from competing countries. The competitive role of U.S. rice would be strengthened if the institutional, economical, legal, and physical barriers to trade were identified and analyzed.

OBJECTIVE: To identify and analyze factors affecting the level of export demand and determine the direction and magnitude of the adjustments needed to improve the competitive position of U.S. rice in world markets.

RESEARCH APPROACHES: Data for the first phase of the study will be obtained from agencies of the U.S. government, private firms, trade associations, and published and secondary sources. Countries studied will reflect the differences in marketing characteristics and practices among the major regions of the world.

A. Data on existing port facilities, number and size of importing firms, size and location of processing and storage facilities, competitiveness of the market, commercial trading customs and practices, methods of handling, channels of distribution, methods of grading and standards used, and government import policies and regulations will be analyzed to determine their effect on rice imports.

B. In order to estimate the impact of international trade barriers on rice movements, information pertaining to inter-governmental marketing arrangements, pricing agreements, currency exhange, export subsidies, import levies, and quantity restrictions will be analyzed in relation to U.S. rice exports. These countries will be selected in such a manner that comparison of characteristics of foreign markets can be made between countries that are major importers of U.S. rice and countries that import only small quantities.

C. Multiple regression analysis and other statistical estimating procedures that conform with the problem at issue will be used to determine the relationship, if any, among the market characteristics and the level of export demand for rice. The results will be interpreted to indicate changes the U.S. rice industry can make to obtain a larger share of the export market.

POTENTIAL BENEFITS: Information on quality requirements, trade restrictions and potential growth of markets in various world regions will serve as a guide to government agencies and trade interests in formulating policy to better serve the rice industry.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.4		
No increase	0.4		
10% increase	0.4		
Recommended	-	1.5	2.0

Summary of Research Problem Area 604 - Product Development and Marketing for Foreign Markets

Problem	Priority	SMY's				
		Current	No Increase	10% Increase	Recommended 1979	1984
A. Product Development and Marketing for Foreign Markets	3	3.7	3.7	4.1	4.0	4.0

PRODUCT DEVELOPMENT AND MARKETING FOR FOREIGN MARKETS

RPA 604-A

PRIORITY: 3

SITUATION: Sales of rice and rice by-products in foreign markets are an important source of income for American farmers and contribute substantially to the U.S. balance of payments. Product development and processing are essential phases of meeting the particular requirements of different foreign groups.

OBJECTIVES: To investigate processes for development of protein-rich foods acceptable in foreign markets from rice bran and polish and to study mill by-product composition and properties.

RESEARCH APPROACHES:

A. Analyze and characterize rice bran, polish, and hulls.

B. Stablilize bran and polish by enzyme inactivation, especially of lipase.

C. Characterize lipase.

D. Recover stable high-protein, low-fiber material from full-fat bran and polish by wet extractions or dry segregations including variations in original milling.

E. Devise methods for incorporating products in or converting them to attractive foods based on properties determined.

POTENTIAL BENEFITS: Success in developing new and improved products that appeal to consumers in foreign countries will expand uses of rice by-products and supply supplemental protein foods for countries with specific dietary deficiencies.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	3.7		
No increase	3.7		
10% increase	4.1		
Recommended	-	4.0	4.0

Summary of Research Problem 702 - Food Protection from Toxicity

Problem	Priority	SMY's Current	SMY's No Increase	SMY's 10% Increase	SMY's Recommended 1979	SMY's Recommended 1984
A. Detection and Prevention of Mycotoxin Contamination of Rice	3	0.2	0.2	0.2	2.0	2.0

DETECTION AND PREVENTION OF MYCOTOXIN CONTAMINATION OF RICE

RPA 702-A

PRIORITY: 3

SITUATION: In 1940, Japanese investigators reported toxic fungal metabolites in yellowed rice infected with species of the genus Penicillium. Death and/or the development of beriberi-like symptoms occurred after consumption of yellowed rice. More than 25 toxic or antibiotic substances produced by more than 30 different species of the genus have now been described. P. citreo-viride, P. islandicium, P. puberulum and P. citrinum are among the toxic Penicillia often infecting rice. Aflatoxin B_1 and ca 18 related compounds are often produced by fungi of the Aspergillus flavus group. These compounds are potent carcinogens. Food stocks found contaminated are subject to condemnation and seizure. Many other species of the genus Aspergillus have been implicated as producers of toxic metabolites. Rice has been shown to be an excellent substrate for the growth of toxic strains of A. flavus and for the production of the aflatoxins. A. flavus species often are a major part of the mycoflora of rice after harvest and spread rapidly through a lot of threshed rice under favorable conditions of temperature and humidity. The Penicillia and other species of the Aspergilli often infect rice and there may be a succession of species that predominate during conditioning and storage.

Although aflatoxins and some of the Penicillium toxins have been detected in rice, there has been little or no investigation of the metabolites of the other common and prevalent fungi. To maintain high standards of safety and nutrition in rice, it is essential that work be continued and extended in this area.

OBJECTIVES: To prevent or remove mycotoxin-contaminated rice from domestic rice stocks. To develop the techniques needed to maintain the safety of rice.

RESEARCH APPROACHES:

A. Determine the prevalence of the strains and species of fungi capable of producing mycotoxins in rice.

B. Develop or adopt methods for the detection and quantification of mycotoxins in rice.

C. Investigate and determine the environmental conditions, including varietal reaction, under which mycotoxins are produced.

D. Develop methods for the removal or detoxification of mycotoxin-contaminated rice.

E. Improve methods of handling, drying, and storage to prevent mycotoxin contamination.

F. Coordinate with research in RPA's 408 and 503.

POTENTIAL BENEFITS: Reduce loss to the rice industry by avoiding condemnation and seizure of contaminated rice. Protect the public health by insuring that rice in market channels will be wholesome and free of toxigenic substances of fungal origin.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.2		
No increase	0.2		
10% increase	0.2		
Recommended	-	2.0	2.0

Summary of Research Problem Area 901 - Alleviation of Pollution

Problem	Priority	Current	No Increase	10% Increase	Recommended 1979	Recommended 1984
A. Alleviation of Air Pollution Caused by Dust	2	0.0	0.0	0.0	2.0	2.0
B. Disposal of Rice Hulls	2	0.0	0.0	0.0	2.0	2.0

ALLEVIATION OF AIR POLLUTION CAUSED BY DUST

RPA 901-A

PRIORITY: 2

SITUATION: Handling of rough rice at commercial dryers, mills, and seed rice plants, as well as transportation of hulls, may result in air pollution caused by dust escaping into the atmosphere. Compliance with state air quality standards might require the addition of expensive, non-productive equipment.

Research is needed to determine the least expensive method, and to develop new methods, of removing the particulate which accompanies handling of rough rice.

OBJECTIVES: To determine handling methods for rough rice at dryers and mills that minimize air pollution and to determine the least expensive method and develop better methods of removing particulate from air exhaust systems.

RESEARCH APPROACHES:

A. Monitor for air pollution at selected dryers and mills.

B. Study dust control equipment to determine the least expensive method for rice dryers and mills.

C. Develop improved dust control methods and equipment.

POTENTIAL BENEFITS: Compliance with state air quality standards by the most economical method will allow small, agriculturally-related industries to remain in business, resulting in reduced food prices to consumers. Minimizing air pollution will improve health of employees and people living in the vicinity.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.0		
10% increase	0.0		
Recommended	-	2.0	2.0

DISPOSAL OF RICE HULLS

RPA 901-B

PRIORITY: 2

SITUATION: About one-fifth the weight of the harvested rice crop is hulls and chaff. Some rice hulls find profitable outlets as cattle roughage, poultry litter, and for other purposes, but much of the amount of hulls produced must be disposed of. State and federal regulations increasingly demand that hulls be disposed of in ways that do not contaminate the environment. Because of regulations, disposal is increasingly an economic problem to the rice milling industry. When disposal by burning is the most practical method, research is needed to determine possible uses of the resulting heat energy.

OBJECTIVE: To develop methods for efficient disposal of rice hulls and chaff.

RESEARCH APPROACHES:

A. Develop efficient methods for automatically loading trucks with rice hulls and methods of unloading and spreading or distributing hulls at disposal site.

B. Develop methods of combustion of hulls, with controls that will prevent smoke pollution, and determine efficient methods of disposal or utilization of the rice hull ash, e.g., as landfill.

C. Investigate methods, such as shelling rice in the field during harvest, that would obviate the need to dispose of hulls.

D. Coordinate with research under RPA 407.

POTENTIAL BENEFITS: Present methods of rice hull disposal will be made more efficient, cheaper, and will result in less environmental pollution. Development of profitable outlets for using rice hulls will reduce the amount of hulls that need to be disposed of and will result in new industrial opportunities in rural areas and lower cost products for consumers. Efficient combustion may be the least laborious method of disposal and the released heat energy might be used to save other kinds of energy.

ALLOCATION OF SMY'S

	1974	1979	1984
Current	0.0		
No increase	0.0		
10% increase	0.0		
Recommended	-	2.0	2.0